A60440

Ballantine

INSTRUCTION MANUAL

INSTRUMENT SHOP

AC VOLTMETERS 3015A 3045A 3046A Series

APPLICABLE TO:
3015A beginning with Serial No. Prefix 050-
3015A MOD-92 beginning with Serial No. Prefix 050-
3015A MOD-95 beginning with Serial No. Prefix 020-
3045A beginning with Serial No. Prefix 050-
3046A beginning with Serial No. Prefix 050-
See Section 7 for manual backdating changes

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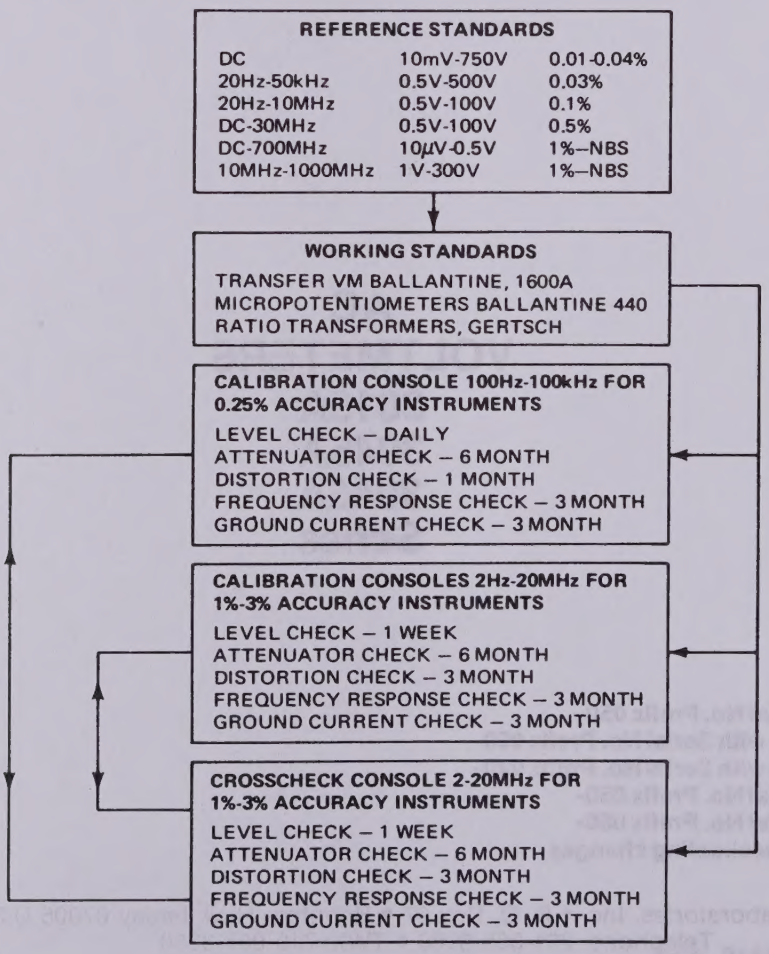
August 1978

WARRANTY

This Ballantine Laboratories, Inc. product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except for batteries, electron tubes, vacuum thermocouples, and certain other components, if any, listed in this manual. Ballantine Laboratories, Inc. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Ballantine Laboratories, Inc. prepaid, and provided the proper preventive maintenance and calibration procedures as listed in this manual have been followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BALLANTINE LABORATORIES, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

CERTIFICATION

Ballantine Laboratories, Inc. certifies that this equipment meets all applicable Ballantine specifications at time of shipment from the factory as determined by thorough testing and inspection. Ballantine further certifies that its measurements are traceable to the United States National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.


REFERENCE STANDARDS
DC 10mV-750V 0.01-0.04%
20Hz-50kHz 0.5V-500V 0.03%
20Hz-10MHz 0.5V-100V 0.1%
DC-30MHz 0.5V-100V 0.5%
DC-700MHz 10μV-0.5V 1%—NBS
10MHz-1000MHz 1V-300V 1%—NBS
WORKING STANDARDS
TRANSFER VM BALLANTINE, 1600A
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH
CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS
LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfied the requirements of MIL-I-45208

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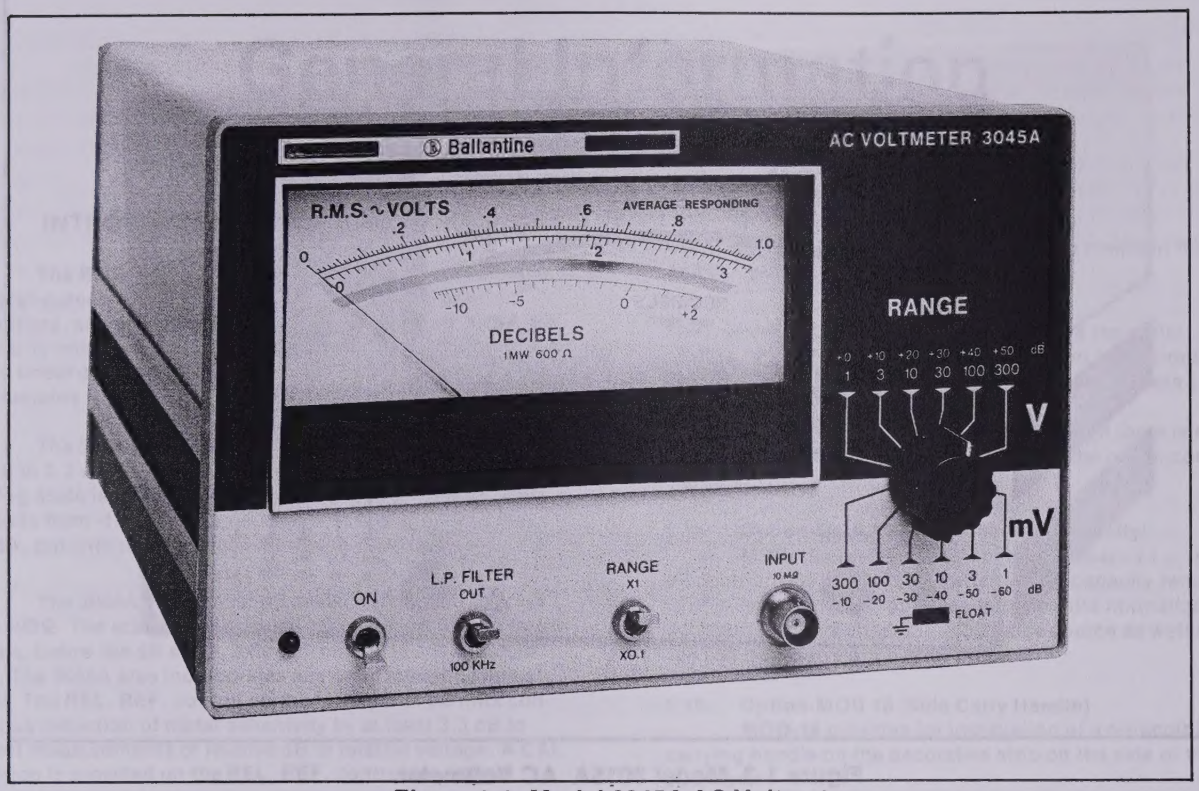


Figure 1-1. Model 3045A AC Voltmeter

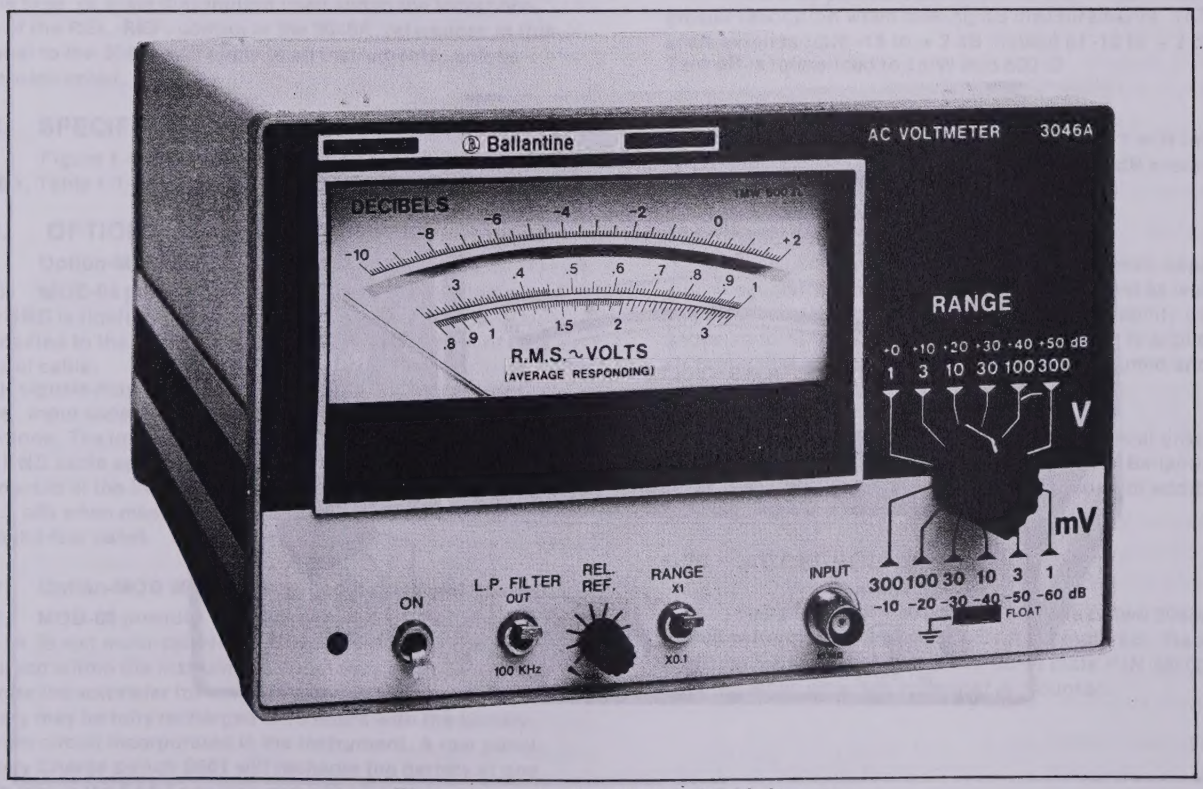


Figure 1-2. Model 3046A AC Voltmeter

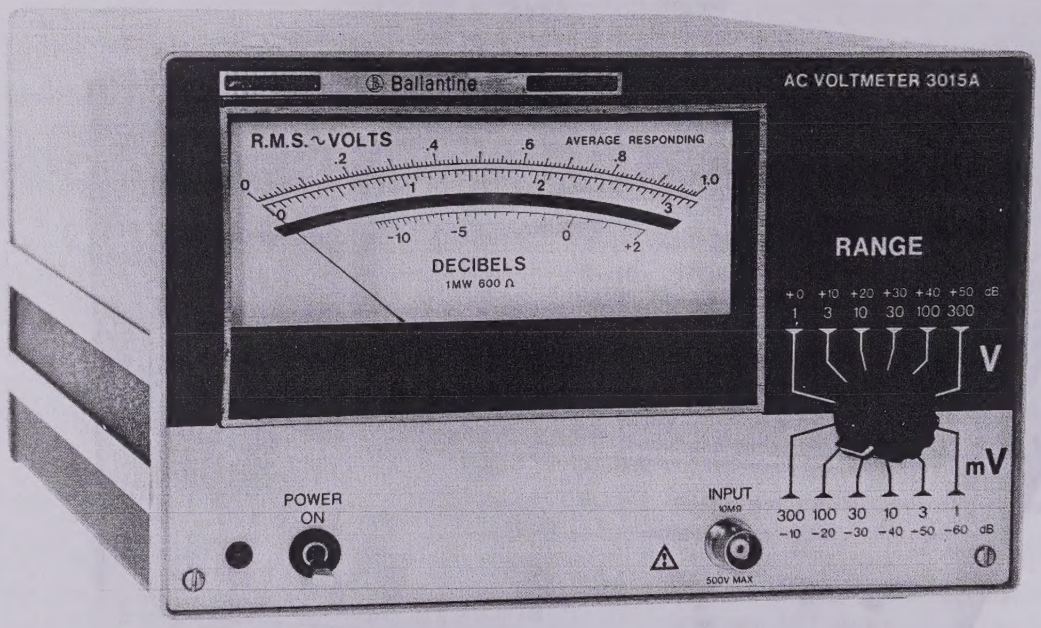


Figure 1-3. Model 3015A AC Voltmeter

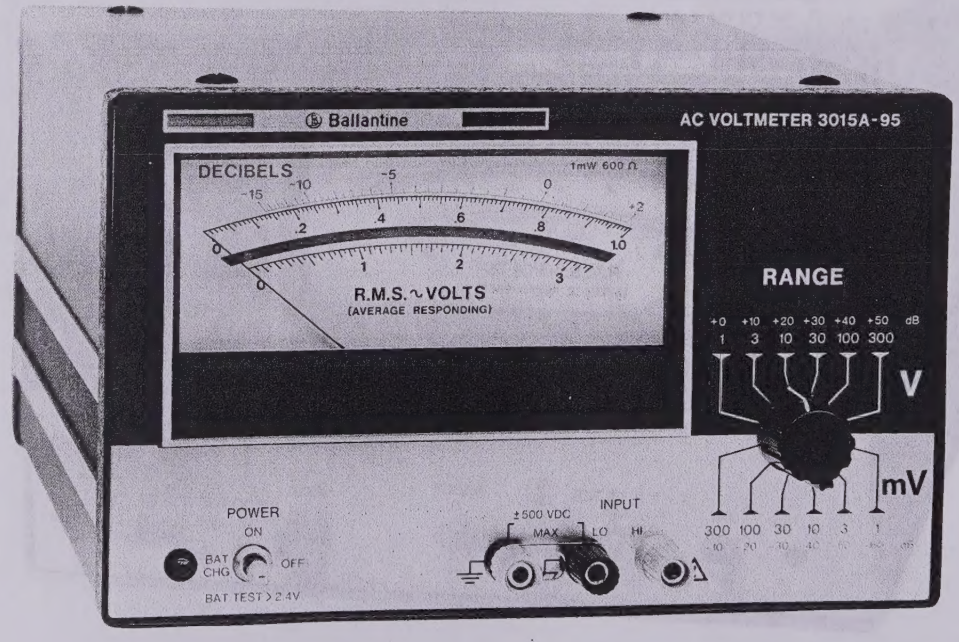


Figure 1-4. Model 3015A-MOD 95 AC Voltmeter

General Information

1-1. INTRODUCTION

1-2. The Ballantine 3045A, 3046A, and 3015A are versatile, general-purpose, wide-band ac voltmeters, wide-band ac amplifiers, and ac to dc converters. The 3045A and 3015A are primarily intended for voltage measurements while the 3046A has a linear dB scale and is primarily a dB meter. All the instruments incorporate easy-to-read dB and voltage scales.

1-3. The 3045A has two linear voltage scales from 0 to 1 and 0 to 3.2 with a logarithmic dB scale beneath. Zero dB on the log scale is referenced to 1 mW into 600 Ω. The dB scale extends from -12 dB to + 2 dB. The 3015A is similar to the 3045A, but with reduced bandwidth and sensitivity.

1-4. The 3046A has a linear dB scaled referenced to 1mW into 600Ω. The scale extends from -10 to + 2 dB. Two voltage scales, below the dB scale, extend from .25 to 1.0 and .8 to .3.2. The 3046A also incorporates a relative reference adjustment. The **REL. REF.** control on the front panel permits continuous reduction of meter sensitivity by at least 3.3 dB to permit measurements of relative dB or relative voltage. A **CAL** position is provided on the **REL. REF.** control for normal calibrated measurements.

1-5. Since the 3045A and 3015A differ from the 3046A only in the type of scale distribution used and in the incorporation of the **REL. REF.** control in the 3046A, references in this manual to the 3045A will apply to all instruments, unless otherwise noted.

1-6. SPECIFICATIONS

1-7. Figure 1-1 shows the 3045A and Figure 1-2 shows the 3046A. Table 1-1 provides a list of specifications.

1-8. OPTIONS

1-9. **Option-MOD 04 (Rear Panel input connector)**

1-10. **MOD-04** provides a **BNC** input connector at the rear. The **BNC** is floating with respect to the chassis and is connected to the front panel **BNC** thru a short lenght of 50Ω coaxial cable.
Input signals may be connected at both the front and rear panel. Input capacity is less than 60 pF on all **RANGE** switch positions. The instrument is calibrated from the front panel. The **BNC** cable assembly and a 50 Ω termination should be connected at the front panel to avoid transmission line errors (1.5 nS) when measuring high frequencies with signal input from the rear panel.

1-11. **Option-MOD 05 (Internal NiCad Battery and Charger)**

1-12. **MOD-05** provides internal rechargeable battery operation. A 28 volt multi-cell Nickel Cadmium (NiCad) Battery is mounted within the instrument. When fully charged it will operate the voltmeter for nominally seven to eight hours. The battery may be fully recharged in 16 hours with the battery charger circuit incorporated in the instrument. A rear panel Battery Charge switch **S501** will recharge the battery at one tenth rate in the **FAST** position and will trickle charge in **NORM** position. **FAST** should only be used twenty hours at a time. **NORM** may be used continuously to maintain the battery fully charged.

The internal battery pack is used to operate the meter off-line, in the field, and when full isolation is required to avoid ground current and power line frequency errors.

1-13. When using internal battery operation there is no ground return for the instrument through the power cord. Use caution to avoid electrical shock.

1-14. **Option-MOD 10 (Constant input capacity)**

MOD-10 provides constant input capacity (± 1pF) on all positions of the **RANGE** switch. Input capacity remains 22pF ±2pF. Constant input capacity permits normalized calibration from a constant impedance source as well as the full use of passive attenuator probes.

1-15. **Option-MOD 16 (Side Carry Handle)**

MOD-16 provides for installation of a retractable carrying handle on the decorative strip on the side of the instrument.

1-16. **Option-MOD 30 [3045A and 3015A Series Only]**

MOD-30 places logarithmic dB scale uppermost for greater resolution when making dB measurements. This dB scale extends from -15 to + 2 dB instead of -12 to + 2 dB. Zero dB is referenced to 1mW into 600 Ω

1-17. **Option MOD 31 [3046A ONLY]**

MOD-31 provides a zero dBV reference 1 mW into 1000Ω, instead of 1 mW into 600Ω. The linear dB scale extends from -12 to 0 dB.

1-18. **Option-MOD 90**

MOD-90 provides additional environmental capability. A special "liquid" damped meter movement as well as additional mechanical supports increase relilability under undue shock and vibration. A humidity sealant is applied to all applicable circuit areas to optimize use in humid and tropical environments.

1-19. Additional options are available on special order to provide customized instruments. Contact your Ballantine local engineering representative or the factory for additional information.

1-20. ACCESSORIES

1-21. **Rack Mount Kit 800-06** mounts one or two 3045A Series voltmeters in a standard E.I.A. 19 inch rack. Rack height is 5.2 inches. A half-panel cover plate P/N 38100371 is required when only one voltmeter is mounted.

1-22. **Probe Kit 10601 ( )**
Attenuator Probe
Input impedance 10 MΩ/12pF
Division Ratio 10:1
Bandwidth dc to 70 MHz
Maximum Input Voltage 600 V rms
Cable length 5 feet (152 cm)

To use this probe, a one megohm adapter, Model 12614A, is required at the voltmeter input connector to match the probe to the 10 megohm voltmeter input. For 3015A-MOD 95 with a 2 megohm input, order Model 12613A.

1-23. **Model 1301 AC High Voltage Probe**
Maximum input voltage may be extended to 10,000 V rms by using an optional 1000:1 capacitave divider probe. Order Model 1301A for BNC cable connector or Model 1301B for dual banana connectors.

1-24. **Adapter, BNC to Dual Binding Post Model 12622A**
Used to convert BNC input connector to two binding posts.

1-25. Adapter, Dual Binding Post to BNC female Model 12616A (shielded) or Model 12617A. Used to convert binding post input of 3015A-MOD 95 to BNC female.

1-26. **50Ω Feed-thru termination, BNC to BNC ,2W**
Model 12630A

1-27. **Protective Carrying Case**
Padded vinyl with zipper closure. Model 10755A

1-28. **Shielded input cable** 4 feet **BNC** to **BNC**, 50Ω .
Model 12249D

1-29. **Shielded input cable** 4 feet **BNC** to Alligator clips
Model 12250D

1-30. INSTRUMENT AND MANUAL IDENTIFICATION

1-31. These Ballantine instruments are identified by a two section serial number. The first three digits section of this number must appear on the title page of this manual. Addendum sheets supplied with the manual will define technical corrections differences between your instrument and the unit described in this manual.

1-32. If applicable, back dating information is located at the very end of this manual in Section 7. This backdating information pertains to instruments with serial number prefixes listed on the title page of Section 7.

TABLE 1–1A. SPECIFICATIONS (Model 3045A)

Voltage Ranges
x 1 Multiplier: 1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.
x 0.1 Multiplier: x 0.1 multiplier increases sensitivity on all ranges by a factor of 10 (+ 20 dB) and extends the 1 mV range to 100 μV full scale and the 3 mV range to 300 μV full scale.

Frequency Range
Usable 2 Hz to 20 MHz.
Calibrated 5 Hz to 15 MHz.

Calibration
Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Input Impedance
10 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 10 megohms shunted by less than 20 pF on the 1 V to 300 V ranges. Option MOD-10 provides constant input capacity ± 1 pF at less than 25 pF for all ranges.

Off Ground Operation
The voltmeter may be floated with respect to case ground. A screwdriver activated slide switch located on the front panel selects off ground operation to 300 V (DC plus peak AC). Common mode rejection is greater than 120 dB at DC and typically 80 dB at 60 Hz on the 30 mV to 300 V ranges.

Overvoltage Protection
500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 100 μV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges.

Noise
Referred to input with 1000 Ω shielded and grounded termination.
100 μV to 300 mV range.
L.P. Filter In < 15 μV (< 10 μV with MOD-05).
L.P. Filter Out < 25 μV (< 20 μV with MOD-05).
Noise may cause zero offset on most sensitive ranges.

Note: Noise adds to the input signal in the relation:

$$\text{Meter Reading} = (\text{Signal})^2 + (\text{noise})^2$$

Low Pass Filter
100 kHz low pass filter selected by front panel switch. Optimizes measurements on low frequency signals by attenuating high frequency noise.

Amplifier AC Outputs
Measured into open circuit load of 10 megohms shunted by < 10 pF.
50 Ω Output Impedance: Greater than 150 mV rms for full scale meter indication. DC coupled with response 5 Hz to 10 MHz.
Accuracy of frequency response:
5 Hz to 1 kHz ± 10%
1 kHz to 4 MHz ± 3%
4 MHz to 10 MHz ± 10%
600 Ω Output Impedance: Greater than 1 V rms for full scale meter indication.
Accuracy of frequency response:
5 Hz to 1 kHz ± 10%
1 kHz to 4 MHz ± 5%
4 MHz to 10 MHz ± 20%
Gain: +60 dB to −50 dB.

TABLE 1–1A. SPECIFICATIONS (Continued)
(Model 3045A)

AC to DC Converter Output

+ 1 V DC output for full scale meter deflection on all ranges. DC output is directly proportional to the input signal.

Output resistance is nominally 500 Ω.

Response time: less than 1 second to within 1% of final value of a step change.

Meter Scales

Linear voltage scales uppermost.

0 to 1 V scale; 100 divisions.

0 to 3.2 V scale, 64 divisions.

dB scale is logarithmic.

−12 to +2 dB; 120 linear divisions.

0 dB is referenced to 1 mW into 600 Ω.

Mirror backed meter and narrow pointer provide anti-parallax readings.

Meter Response Time

≈ 1 second after application of input signal.

Meter Protection

Meter is electronically protected from transient and continuous overloads greater than 1.5 times full scale.

Environmental Characteristics

The instrument is designed to meet the environmental characteristics of MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.

All accuracies refer to reference conditions of 25°C ± 5°C.

Temperature:

0 to 55°C Operating.

−54°C to +75°C Storage.

Altitude:

0 to 3 Km Operating.

0 to 15 Km Non-Operating.

Humidity:

0 to 95% RH to 45°C.

Shock, Vibration, Transit:

Per MIL-T-21200B, Class 4.

Power

AC Power: 100/120/220/240 volts AC −8% +10%. 50 to 1000 Hz, 5 watts.

External DC Power: Binding post connectors on the rear panel connect to floating DC source or battery. Input voltage range from 28 to 44 V DC with current drain of approximately 80 μA.

Internal Battery (Option MOD-05): Optional internal Ni Cad 28 volt battery with charger. 8 hour operation from 16 hour recharge.

Dimensions

Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;

Width: 211 mm (8.34 in.);

Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight

Basic Instrument:

Net – 2.7 kg (6.0 lb.), Shipping – 4.0 kg (8.8 lb.)

With Battery MOD-05:

Net – 3.4 kg (7.5 lb.), Shipping – 4.7 kg (10.4 lb.)

Accuracy

Voltmeter:

Accuracy: ± (% Full Scale + % Reading) above one tenth Full Scale.

	5 Hz	10 Hz	40 Hz	1 MHz	2 MHz	4 MHz	10 MHz	15 MHz
Range X1	±(5 + 5)	±(2.0 + 2.0)	±(1 + 0)	±(1 + 0)	±(1.5 + 1.5)	±(2.5 + 2.5)	±(5 + 5)	

	10 Hz	20 Hz	40 Hz	100 kHz	500 kHz	6 MHz
Range X0.1 (100 μV range)	±(5 + 5)	±(2 + 2)	±(1 + 1)	$\pm 1 \begin{smallmatrix}+1\\-2.5\end{smallmatrix}$	$\pm 2.5 \begin{smallmatrix}+1\\-2.5\end{smallmatrix}$	

Accuracy specification applies from 1/3 full scale to full scale

AC to DC Converter Output:

Accuracy: ± (% Full Scale + % of Reading) above 1/3 of Full Scale.

	5 Hz	20 Hz	100 Hz	500 kHz	1 MHz	10 MHz	15 MHz
Range X1	±(2.5 + 2.5)	±(1 + 1)	±(1/4 + 1/4)	±(1/2 + 1/2)	±(2.5 + 2.5)	±(5 + 5)	

	10 Hz	20 Hz	100 Hz	100 kHz	1 MHz	6 MHz
Range X0.1 (100 μV/300 μV ranges)	±(2.5 + 2.5)	±(1 + 1)	±(0.4 + 0.25)	±(1 + 1)	±(2.5 + 2.5)	

TABLE 1–1B. SPECIFICATIONS
(Model 3046A)

Voltage Ranges

x 1 Multiplier: 1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.

x 0.1 Multiplier: x 0.1 multiplier increases sensitivity on all ranges by a factor of 10 (+ 20 dB) and extends the 1 mV range to 100 μV full scale and the 3 mV range to 300 μV full scale.

Frequency Range

Usable 2 Hz to 20 MHz.

Calibrated 5 Hz to 15 MHz.

Calibration

Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Input Impedance

10 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 10 megohms shunted by less than 20 pF on the 1 V to 300 V ranges. Option MOD-10 provides constant input capacity ± 1 pF at less than 25 pF for all ranges.

Off Ground Operation

The voltmeter may be floated with respect to case ground. A screwdriver activated slide switch located on the front panel selects off ground operation to 300 V (DC plus peak AC). Common mode rejection is greater than 120 dB at DC and typically 80 dB at 60 Hz on the 30 mV to 300 V ranges.

Overvoltage Protection

500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 100 μV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges.

Noise

Referred to input with 1000 Ω shielded and grounded termination.

100 μV to 300 mV range.

L.P. Filter In $<$ 15 μV ($<$ 10 μV with MOD-05).

L.P. Filter Out $<$ 25 μV ($<$ 20 μV with MOD-05).

Noise may cause zero offset on most sensitive ranges.

Note: Noise adds to the input signal in the relation:

$$\text{Meter Reading} = \sqrt{(\text{Signal})^2 + (\text{noise})^2}$$

Low Pass Filter

100 kHz low pass filter selected by front panel switch. Optimizes measurements on low frequency signals by attenuating high frequency noise.

Amplifier AC Outputs

Measured into open circuit load of 10 megohms shunted by $<$ 10 pF.

50 Ω Output Impedance: Greater than 150 mV rms for full scale meter indication. DC coupled with response 5 Hz to 10 MHz.

Accuracy of frequency response:

5 Hz to 1 kHz ± 10%

1 kHz to 4 MHz ± 3%

4 MHz to 10 MHz ± 10%

600 Ω Output Impedance: Greater than 1 V rms for full scale meter indication.

Accuracy of frequency response:

5 Hz to 1 kHz ± 10%

1 kHz to 4 MHz ± 5%

4 MHz to 10 MHz ± 20%

Gain: +60 dB to −50 dB.

AC to DC Converter Output

+ 1 V DC output for full scale meter deflection on all ranges. DC output is directly proportional to the input signal.

Output resistance is nominally 500 Ω.

Response time: less than 1 second to within 1% of final value of a step change.

Meter Scales

Linear dB scale uppermost.

−10 dB to +2 dB; 120 divisions.

0 dB referenced to 1 mW into 600 Ω.

Voltage Scales:

.25 to 1;

.8 to 3.2.

Mirror backed meter and narrow pointer provide anti-parallax readings.

Meter Response Time

≈ 1 second after application of input signal.

Meter Protection

Meter is electronically protected from transient and continuous overloads greater than 1.5 times full scale.

Relative Reference Control

Front panel control which permits continuous reduction in sensitivity by more than 3.3 dB to permit relative voltage and dB measurements. A CAL switch provides for normal calibrated absolute measurements.

Environmental Characteristics

The instrument is designed to meet the environmental characteristics of MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.

All accuracies refer to reference conditions of 25°C ± 5°C.

Temperature:

0 to 55°C Operating.

−54°C to +75°C Storage.

Altitude:

0 to 3 Km Operating.

0 to 15 Km Non-Operating.

Humidity:

0 to 95% RH to 45°C.

Shock, Vibration, Transit:

Per MIL-T-21200B, Class 4.

TABLE 1–1B. SPECIFICATIONS (Continued)
(Model 3046A)

Power

AC Power: 100/120/220/240 volts AC –8% +10%. 50 to 1000 Hz, 5 watts.

External DC Power: Binding post connectors on the rear panel connect to floating DC source or battery. Input voltage range from 28 to 44 V DC with current drain of approximately 80 μA.

Internal Battery (Option MOD-05): Optional internal Ni Cad 28 volt battery with charger. 8 hour operation from 16 hour recharge.

Dimensions

Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;
Width: 211 mm (8.34 in.);
Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight

Basic Instrument:
Net – 2.7 kg (6.0 lb.), Shipping – 4.0 kg (8.8 lb.)
With Battery MOD-05:
Net – 3.4 kg (7.5 lb.), Shipping – 4.7 kg (10.4 lb.)

Accuracy

Voltmeter:

Accuracy: ± (% Full Scale + % Reading) above one tenth Full Scale.

	5 Hz	10 Hz	40 Hz	1 MHz	2 MHz	4 MHz	10 MHz	15 MHz
Range X1	±(5 + 5)	±(2.0 + 2.0)	±(1 + 0)	±(1 + 0)	±(1.5 + 1.5)	±(2.5 + 2.5)	±(5 + 5)	

	10 Hz	20 Hz	40 Hz	100 kHz	500 kHz	6 MHz
Range X0.1 (100 μV/300 μV ranges)	±(5 + 5)	±(2 + 2)	±(1 + 1)	$\pm 1 \begin{smallmatrix}+1\\-2.5\end{smallmatrix}$	$\pm 2.5 \begin{smallmatrix}+1\\-2.5\end{smallmatrix}$	

Accuracy specification applies from 1/3 full scale to full scale

AC to DC Converter Output:

Accuracy: ± (% Full Scale + % of Reading) above 1/3 of Full Scale.

	5 Hz	20 Hz	100 Hz	500 kHz	1 MHz	10 MHz	15 MHz
Range X1	±(2.5 + 2.5)	±(1 + 1)	±(1/4 + 1/4)	±(1/2 + 1/2)	±(2.5 + 2.5)	±(5 + 5)	

	10 Hz	20 Hz	100 Hz	100 kHz	1 MHz	6 MHz
Range X0.1 (100 μV/300 μV ranges)	±(2.5 + 2.5)	±(1 + 1)	±(0.4 + 0.25)	±(1 + 1)	±(2.5 + 2.5)	

TABLE 1–1C. SPECIFICATIONS
(Model 3015A)

Voltage Ranges
1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.

Frequency Range
Usable 5 Hz to 8 MHz.
Calibrated 10 Hz to 6 MHz.

Calibration
Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Accuracy
± (% of Full Scale + % of Reading) above 1/3 Full Scale.

10 Hz	to	40 Hz	± (5+0)
40 Hz	to	100 kHz	± (2+0)
100 kHz	to	1 MHz	± (5+0)
1 Hz	to	2 MHz	± (5+0)
2 MHz	to	6 MHz	± (6+0)

Input Impedance
10 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 10 megohms shunted by less than 20 pF on the 1 V to 300 V ranges.

Overvoltage Protection
500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 1 mV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges.

Meter Scales
Linear Voltage Scales uppermost.
0 to 1 V scale; 100 divisions.
0 to 3.2 V scale, 64 divisions.
dB scale is logarithmic.
−12 to +2 dB; 120 linear divisions.
0 dB is referenced to 1 mW into 600 Ω.

Meter Response Time
≈ 1 second after application of input signal.

AC Amplifier Output
Measured into open circuit load of 10 megohms shunted by < 10 pF.
600 Ω Output Impedance: Greater than 1 V rms for full scale meter indication.
Accuracy of frequency response:

5 Hz	to	1 kHz	± 10%
1 kHz	to	4 MHz	± 5%
4 MHz	to	10 MHz	± 6%

Environmental Characteristics
The instrument is designed to meet the environmental characteristics of MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.
All accuracies refer to reference conditions of 25°C ± 5°C.
Temperature:
0 to 55°C Operating.
−54°C to +75°C Storage.
Altitude:
0 to 3 Km Operating.
0 to 15 Km Non-Operating.
Humidity:
0 to 95% RH to 45°C.

Power
AC Power: 100/120/220/240 volts AC −8% +10%.
50 to 1000 Hz, 5 watts.

Dimensions
Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;
Width: 211 mm (8.34 in.);
Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight
Basic Instrument:
Net – 2.7 kg (6.0 lb.), Shipping – 4.0 kg (8.8 lb.)
With Battery MOD-05:
Net – 3.4 kg (7.5 lb.), Shipping – 4.7 kg (10.4 lb.)

TABLE 1–1D. SPECIFICATIONS
(Model 3015A – MOD 91)

Voltage Ranges
1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.

Frequency Range
Usable 5 Hz to 12 MHz.
Calibrated 10 Hz to 10 MHz.

Calibration
Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Accuracy
± (% of Full Scale + % of Reading) above 1/3 Full Scale.

10 Hz	to 40 Hz	± (5+0)
40 Hz	to 2 MHz	± (1+0)
2 MHz	to 4 MHz	± (3+0)
4 MHz	to 10 MHz	± (5+0)

Input Impedance
10 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 10 megohms shunted by less than 20 pF on the 1 V to 300 V ranges.

Overvoltage Protection
500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 1 mV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges.

Meter Scales
Linear Voltage Scales uppermost.
0 to 1 V scale; 100 divisions.
0 to 3.2 V scale, 64 divisions.
dB scale is logarithmic.
–12 to +2 dB; 120 linear divisions.
0 dB is referenced to 1 mW into 600 Ω.

Meter Response Time
≈ 1 second after application of input signal.

Environmental Characteristics
The instrument is designed to meet the environmental characteristics of MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.
All accuracies refer to reference conditions of 25°C ± 5°C.
Temperature:
0 to 55°C Operating.
–54°C to +75°C Storage.
Altitude:
0 to 3 km Operating.
0 to 15 km Non-Operating.
Humidity:
0 to 95% RH to 45°C.

Power
AC Power: 100/120/220/240 volts AC –8% +10%.
50 to 1000 Hz, 5 watts.

Dimensions
Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;
Width: 211 mm (8.34 in.);
Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight
Basic Instrument:
Net – 2.7 kg (6.0 lb.), Shipping – 4.0 kg (8.8 lb.)
With Battery MOD-05:
Net – 3.4 kg (7.5 lb.), Shipping – 4.7 kg (10.4 lb.)

TABLE 1–1E. SPECIFICATIONS
(Model 3015A - MOD 92)

Voltage Ranges
1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.

Frequency Range
Usable 5 Hz to 8 MHz.
Calibrated 10 Hz to 4 MHz.

Calibration
Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Accuracy
± (% of Full Scale + % of Reading) above 1/3 Full Scale.
10 Hz to 20 Hz ± (4+0)
20 Hz to 50 Hz ± (2+0)
50 Hz to 1 MHz ± (1+0)
1 Hz to 4 MHz ± (2+0)

Input Impedance
10 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 10 megohms shunted by less than 20 pF on the 1 V to 300 V ranges.

Overvoltage Protection
500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 1 mV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges.

Meter Scales
Linear Voltage Scales uppermost.
0 to 1 V scale; 100 divisions.
0 to 3.2 V scale, 64 divisions.
dB scale is logarithmic.
−12 to +2 dB; 120 linear divisions.
0 dB is referenced to 1 mW into 600 Ω.

Meter Response Time
≈ 1 second after application of input signal.

Noise
Less than 3% of full scale on all ranges.

Amplifier AC Outputs
Measured into open circuit load of 10 megohms shunted by < 10 pF.

50 Ω Output Impedance: Greater than 150 mV rms for full scale meter indication. DC coupled with response 5 Hz to 10 MHz.
Accuracy of frequency response:
5 Hz to 1 kHz ± 10%
1 kHz to 4 MHz ± 5%
4 MHz to 6 MHz ± 10%

AC to DC Converter Output
+ 1 V DC output for full scale meter deflection on all ranges. DC output is directly proportional to the input signal.
Output resistance is nominally 500 Ω.
Response time: less than 1 second to within 1% of final value of a step change.

Environmental Characteristics
The instrument is designed to meet the environmental characteristics of MIL-V-9999B and MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.
All accuracies refer to reference conditions of 25°C ± 5°C.
Temperature:
0 to 55°C Operating.
−54°C to +75°C Storage.
Altitude:
0 to 3 Km Operating.
0 to 15 Km Non-Operating.
Humidity:
0 to 95% RH to 45°C.

Power
AC Power: 100/120/220/240 volts AC −8% +10%.
50 to 1000 Hz, 5 watts.

Dimensions
Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;
Width: 211 mm (8.34 in.);
Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight
Basic Instrument:
Net – 2.7 kg (6.0 lb.), Shipping – 4.0 kg (8.8 lb.)
With Battery MOD-05:
Net – 3.4 kg (7.5 lb.), Shipping – 4.7 kg (10.4 lb.)

TABLE 1-1F. SPECIFICATIONS
(Model 3015A – MOD 95)

Voltage Ranges
1 mV full scale to 300 V full scale in 12 ranges of 1, 3, 10 sequence. 10 dB between ranges.

Frequency Range
Usable 5 Hz to 4 MHz.
Calibrated 5 Hz to 2 MHz.

Calibration
Responds to the absolute average value of the applied signal. Calibrated in rms of a sine wave.

Accuracy
± (% of Full Scale) above 1/3 Full Scale.

	0 to 50°C	0 to −20°C
10 Hz to 1 MHz	± 2% (± .2 dB)	± 8% ± 0.7 dB
5 Hz to 10 Hz	± 5% (± .4 dB)	± 8% ± 0.7 dB
1 MHz to 2 MHz	± 5% (± .4 dB)	± 8% ± 0.7 dB

Off Ground Operation
Signal ground may be ± 500 V DC from case ground for DC isolation. A grounding link between front panel binding posts is provided as a switching means.

Input Impedance
2 megohms shunted by less than 25 pF on 100 μV to 300 mV ranges and 2 megohms shunted by less than 20 pF on the 1 V to 300 V ranges.

Overvoltage Protection
500 V (DC plus peak AC) on all ranges. Limited to 10^7 V Hz on the 1 mV to 300 mV ranges and 10^8 V Hz on the 1 V to 300 V ranges. Fuse protection optional.

Meter Scales
Linear Voltage Scales uppermost.
0 to 1 V scale; 100 divisions.
0 to 3.2 V scale, 64 divisions.
dB scale is logarithmic.
−12 to +2 dB; 120 linear divisions.
0 dB is referenced to 1 mW into 600 Ω.
Option 30 provides dB scale uppermost on meter face for a range of −15 dB to +2 dB.

Meter Response Time
≈ 1 second after application of input signal.

Environmental Characteristics
The instrument is designed to meet the environmental characteristics of MIL-T-28800B, Class 4, for use in portable, bench-top and rack-mounted service in protected environments.
All accuracies refer to reference conditions of 25°C ± 5°C.
Temperature:
−20°C to 55°C Operating.
−54°C to +75°C Storage.
Altitude:
0 to 3 km Operating.
0 to 15 km Non-Operating.
Humidity:
0 to 95% RH to 45°C.
Shock, Vibration, Transit:
Per MIL-T-28800B, Class 4.

Power
Internal Ni Cad battery supply furnished.
Operation: 40 hours per recharge (20 hours at −20°C).
Recharge: Automatic battery recharge when instrument is operated from the AC power line. 24 hour recharge cycle (above 20°C) when instrument power switch is off.
Battery Life: Up to 500 charge recharge cycles with expected mean battery life of 20,000 hours.
Battery Test: Front panel switch permits check of battery charge condition with 2.4 V reading on the meter.
AC Input Power: 100/110/220/240 volts AC.
50 to 100 Hz, 5 watts.

Dimensions
Height: 132 mm (5.21 in.) case, 147 mm (5.81 in.) overall;
Width: 211 mm (8.34 in.);
Depth: 267 mm (10.52 in.) case, 300 mm (11.83 in.) overall.

Weight
4 kg (8.8 lb) Net.
5 kg (11.0 lb) Shipping.

Section 2

Installation

2-1. INTRODUCTION

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 3045A series Voltmeters. Details are provided for initial inspection, power connection, grounding safety requirements, installation information, and repacking instructions for storage or shipment.

2-3. **Unpacking and Initial Inspection**

2-4. Unpacking and handling of the voltmeter requires only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to ascertain that the shipment is complete.

2-5. This instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in perfect electrical order upon receipt. Check the instrument for damage in transit and perform the electrical procedure outlined in paragraph 5-9. If there is indication of damage or deficiency see the warranty in this manual and notify your local Ballantine field engineering representative or the factory.

2-6. CAUTION

It is recommended that the operator be fully familiar with the specifications and all sections of this manual. Failure to do so may compromise the warranty and the accuracy which Ballantine has engineered into your instrument.

2-7. POWER REQUIREMENTS

2-8. The instrument may be operated from:

a. Any source of AC line voltage from 90 to 135 Volts rms and 180 to 270 Volts rms at 48 to 1000 Hz. A switch on the rear panel selects the desired voltage. Some instruments use a 115/230 V slide switch while later instruments use a safety receptacle with 100/120/220/240 V selection.

b. One 28 to 44 Volt battery or floating dc power supply connectedto the **EXT. BAT.** binding posts on the rear panel. Current requirements are nominally 80 mA. The front panel **power** switch also disconnects the external battery.

c. Internal rechargeable battery power supply; (Optional) **MOD-05**. A 28 Volt NiCad battery and charger are installed in the voltmeter. A fully charged battery will operate the instrument for 8 hours. A rear panel mounted **INT. BAT. CHARGE** switch will select 16 hour recharge from the power line when in **FAST** position and will maintain full charge in **NORM** (trickle charge) position. The ac and dc input requirements of paragraph 2-8a and b above apply since battery charging may be accomplished with ac or dc power input.

The dc battery charge input voltage is 35 V to 44 V. The 3015A-MOD 95 is provided with an internal rechargeable NiCad battery to power this instrument for 40 hours. Recharge is accomplished when the power switch is set to OFF and the AC power is connected.

A momentary battery charge indicator switch is located on the power switch and uses the meter to read battery charge. A meter indication greater than 2.4 volts indicates sufficient battery charge to operate the instrument.

Be sure to **FAST** charge the internal battery for eight hours after extended storage or after receiving the instrument from the factory.

— NOTE —

To charge the battery, the front panel power toggle switch must be **ON** and the pilot lamp illuminated.

When operating on internal batteries, the pilot lamp also indicates power **ON** operation and is illuminated to act as a battery charge indicator as long as sufficient battery charge is available to power the instrument.

2-9. **Grounding Requirements**

2-10. To insure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandated that the instrument panel and enclosure be "earth" grounded. All Ballantine instruments are provided with an Underwriters Laboratories (U.L. and C.S.A.) listed three conductor power cable, which when plugged into an appropriate power receptacle, grounds the instrument. The long offset pin on the male end of the power cable carries the ground wire to the long pin of the Euro connector (**DIN** standard) receptacle on the rear panel of the instrument.

2-11. To preserve the safety protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to an "earth" ground.

2-12. When using external dc power or internal battery operation there is no ground return through the power cord. Use caution to avoid electrical shock and consider connecting the instrument cabinet to earth ground through **J8**, the rear panel ground binding post connector.

2-13. **Installation and Mounting**

2-14. The Model 3045A is fully solid state and dissipates minimal power. No special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F), when the relative humidty exceeds 95% or condensation appears anywhere on the instrument.

2-15. **Bench Mounting**

2-16. The Model 3045A is shipped with plastic feet and tilt stand in place and ready for use as a bench or portable instrument. A side carry handle (**MOD-16**) is optionally available. See outline drawing Figure 2-1 for dimensions.

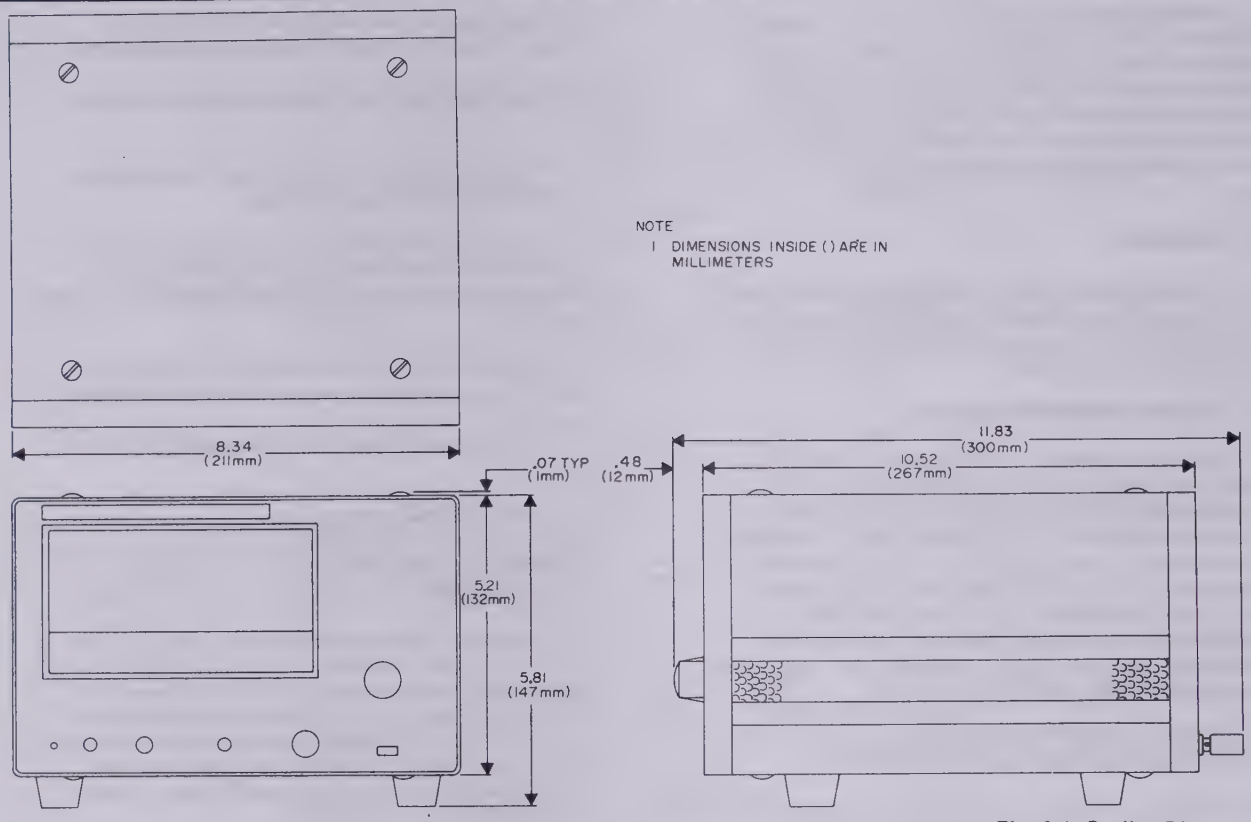


Fig. 2-1. Outline Dimensions

Rack Mount Kit Model 800-06

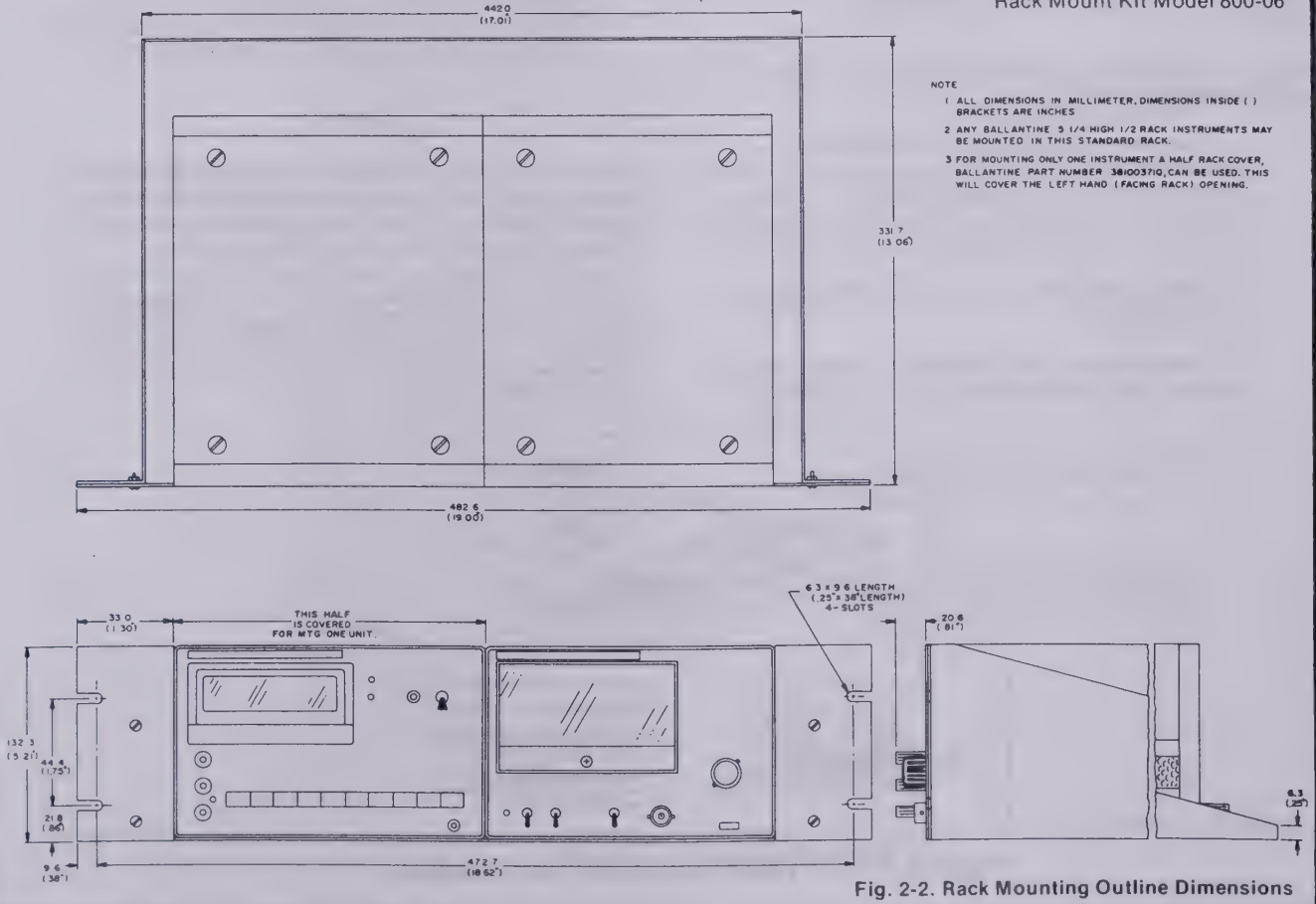


Fig. 2-2. Rack Mounting Outline Dimensions

2-17. The Model 3045A may be rack mounted in a standard 19 inch **EIA** rack. The instrument is of half rack configuration and one or two instruments may be rack mounted in Rack Mount Kit Model 800-06. If only one unit is to be mounted, order cover plate Ballantine part number 38100371. See Figure 2-2 for outline dimensions. Remove plastic feet and tilt stand from bottom cover of voltmeter before mounting in rack adapter.

2-18. **Portable Use**

The Model 3045A may be used in applications requiring portability. A side carry handle (**MOD-16**) and splash proof vinyl protective carry case with zipper closure (Ballantine Model 10755A) are optionally available.

2-19. SHORT TERM STORAGE

2-20. If the Model 3045A is to be stored for a short period of time (less than three months) place cardboard over the panel, and cover the instrument with suitable protective covering such as a plastic bag or strong kraft paper. If the instrument incorporates a rechargeable NiCad battery **(MOD-05 and 3015A-MOD 95)** first fully charge the battery. Place power cable and other accessories with the instrument. Store the covered voltmeter in a clean dry area that is not subject to extreme temperature variations or conditions which may cause moisture to condense on the instrument.

2-21. LONG TERM STORAGE OR REPACKAGING FOR SHIPMENT

2-22. If the Model 3045A is to be stored for a long period or shipped, proceed as directed below. If you have any questions contact your local Ballantine field engineering representative or the Ballantine Service Department at the factory.

2-23. If the original Ballantine supplied packing is to be used proceed as follows:

a. If the original wrappings, packing material and container have been saved, repack the instrument and accessories originally shipped to you. If the original container is not available, one may be purchased thru the Ballantine Service Department at the factory.

b. Be sure the carton is well sealed with strong tape or metal straps.

c. Mark the carton with the model number and serial number with indelible marking. If it is to be shipped, show sending address and return address on two sides of the box and cover all previous shipping labels.

2-24. If the original container is not available, proceed as follows:

a. Before packing the unit, place all accessories into a plastic bag and seal the bag.

b. For extended storage or long shipping only use U.S. Government packaging method **II C** and tape a two-unit bag of desiccant (per **MIL-D-3464**) on the rear cover.

c. Place a 13 cm (5 inch) by 20 cm (8 inch) piece of sturdy cardboard over the front panel for protection.

d. Place the voltmeter into a plastic bag and seal the bag.

e. Wrap the bagged instrument and accessories in one inch thick flexible cellular plastic film cushioning material (per **PPP-C-795**) and place in a barrier bag (per **MIL-B-131**). Extract air from bag and heat seal.

f. Place bagged instrument and accessories into a 250mm (10 inch) x 200mm (8 inch) x 310mm (12 inch) fiber board box (per **PPP-B-636** type **CF**, class **WR**, variety **SW**, grade **V3C**). Fill additional spaces with rubberized hair or cellular plastic cushioning material. Close box in accordance with container specifications. Seal with sturdy water resistant tape or metal straps.

g. Mark container **"DELICATE INSTRUMENT", FRAGILE"** etc. Mark instrument model and serial number and date of packaging. Affix shipping labels as required or mark according to **MIL-STD-129**.

—NOTE—

If the instrument is to be shipped to Ballantine for calibration or repair attach a tag to the instrument fully identifying the owner (with contact, company name, address, telephone number) and complete details indicating the problem, symptoms, and service or repair to be performed. Always include the model and serial number of the instrument on the tag. If possible ship by air freight. In any correspondence, identify the instrument by model number, complete serial number, work authorization order, and date and method of shipment to Ballantine.

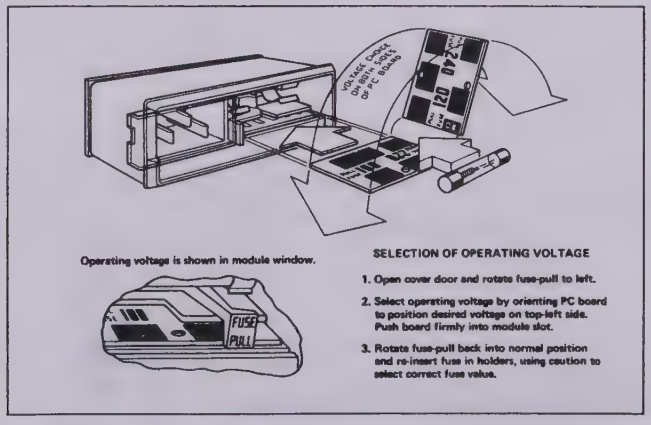

Operating voltage is shown in module window.
FUSE PULL
SELECTION OF OPERATING VOLTAGE
1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

Figure 2-3. Input Power Receptacle Volts Selection.

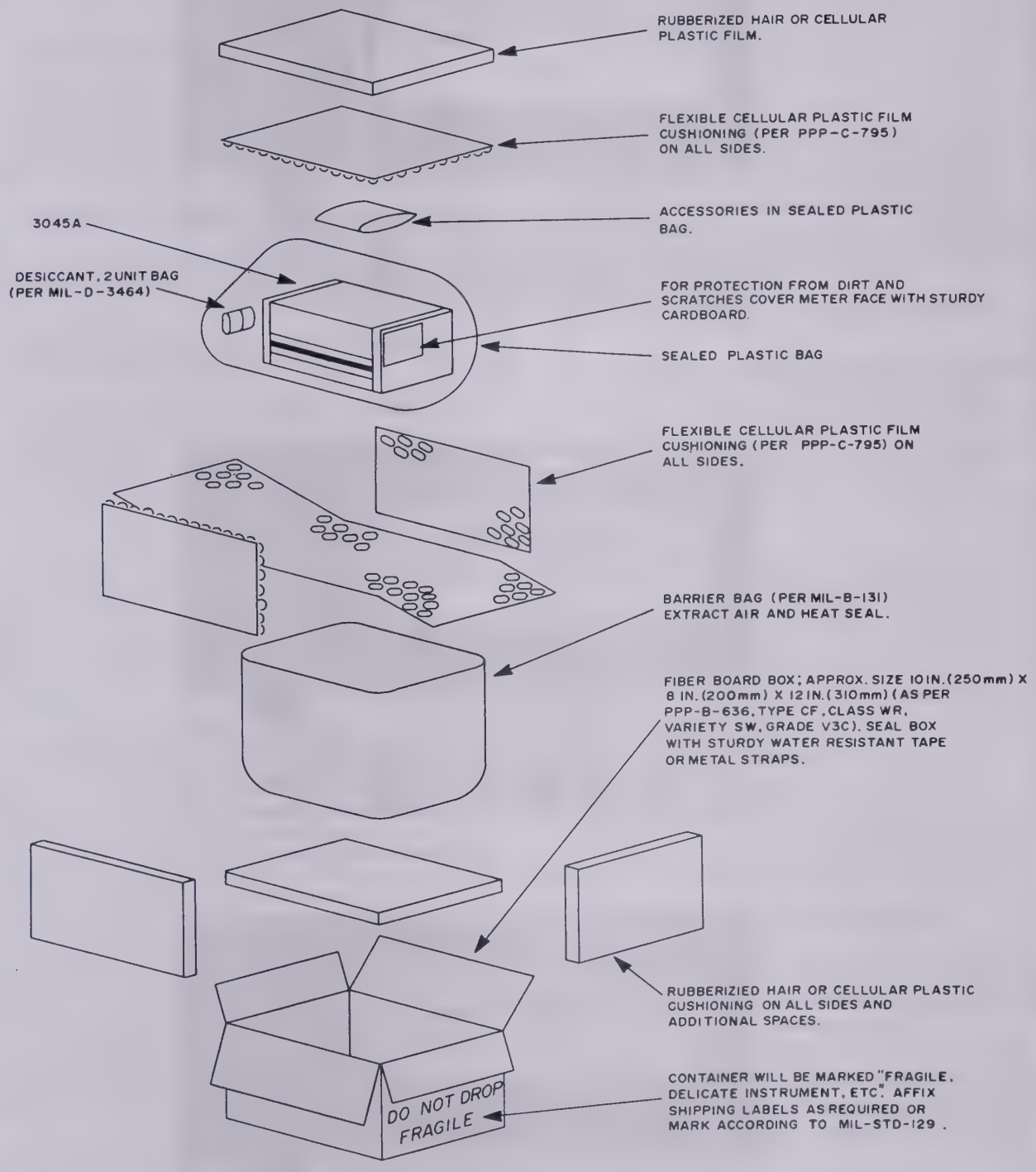

RUBBERIZED HAIR OR CELLULAR PLASTIC FILM.
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
ACCESSORIES IN SEALED PLASTIC BAG.
3045A
DESICCANT, 2 UNIT BAG (PER MIL-D-3464)
FOR PROTECTION FROM DIRT AND SCRATCHES COVER METER FACE WITH STURDY CARDBOARD.
SEALED PLASTIC BAG
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
BARRIER BAG (PER MIL-B-131) EXTRACT AIR AND HEAT SEAL.
FIBER BOARD BOX; APPROX. SIZE 10 IN. (250mm) X 8 IN. (200mm) X 12 IN. (310mm) (AS PER PPP-B-636, TYPE CF, CLASS WR, VARIETY SW, GRADE V3C). SEAL BOX WITH STURDY WATER RESISTANT TAPE OR METAL STRAPS.
RUBBERIZIED HAIR OR CELLULAR PLASTIC CUSHIONING ON ALL SIDES AND ADDITIONAL SPACES.
CONTAINER WILL BE MARKED "FRAGILE, DELICATE INSTRUMENT, ETC." AFFIX SHIPPING LABELS AS REQUIRED OR MARK ACCORDING TO MIL-STD-129 .
DO NOT DROP
FRAGILE

Figure 2-4. Packing Drawing

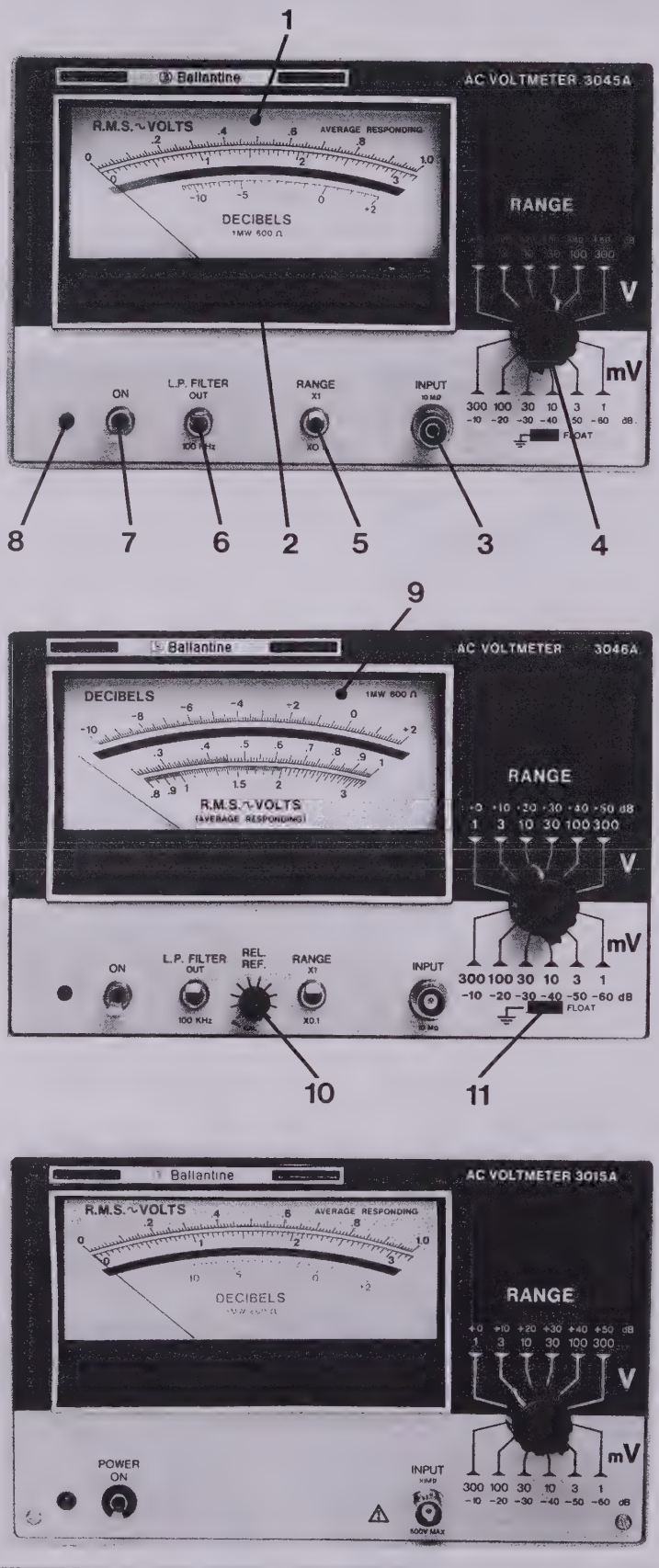


Figure 3-1. Front Panels: Model 3045A, 3046A, and 3015A.

Operating Instructions

3-1. INTRODUCTION

3-2. This section contains instructions and information required for the operation of the Ballantine 3045 Series of AC Voltmeters. Included are identification of controls, connectors, options and indicators as well as turn on procedures and operating instructions.

3-3. CONTROLS, INDICATORS and CONNECTORS

3-4. The instrument controls, indicators, and connectors are identified on Figures 3-1 through 3-4 and described in Table 3-1.

3-5. METER MECHANICAL ZERO ADJUSTMENT (3045A AND 3015A ONLY)

3-6. The mechanical meter zero adjustment is a screwdriver adjustment located in the center of the meter just below the scale. If the meter pointer does not indicate zero after the voltmeter power has been off for a minute or longer, mechanically zero the meter as indicated below:

—NOTE—

The mechanical meter zero adjustment applies only to zero based linear voltage scale meters. **DO NOT** adjust the mechanical meter zero on the 3046A meters with logarithmic movements. These meters are carefully set by the manufacturer and meter linearity may be destroyed if the user misadjusts the mechanical zero adjust on non-zero voltage scale meters.

a. The meter mechanical adjustment screw is located centrally on the meter and below the scale. Rotate the screw **CLOCKWISE** until the meter pointer is to the left of zero on the voltage scale and moving upscale toward zero. Be sure the instrument is in its normal operating position.

b. Continue to turn the adjustment screw clockwise and **STOP** when the meter pointer is precisely on the zero mark. If the meter needle goes beyond zero, repeat step a.

c. When the meter pointer is precisely over the zero mark, turn the adjustment screw slightly **COUNTER CLOCKWISE** to back off the tension on the meter taut band suspension. If the pointer moves to the left, repeat all the above steps, but use less counter clockwise rotation.

3-7. POWER REQUIREMENTS

a. **AC Line Voltage Power**

If ac line voltage power is used, be sure that the Selector Switch on the rear panel is in the correct position.

-WARNING-

Failure to have the Selector Switch in the correct position can cause serious damage to your instrument and may void the warranty.

Turn the power **ON** toggle switch to **ON** and note that the pilot lamp will light when the power is applied.

b. **External DC/Battery Power**

If external dc power supply or batteries are used to power the instrument, connect either to the binding post connectors **J6** and **J7** on the rear panel. The dc power source must be floating with respect to the input connections of the voltmeter. Observe polarity by always connecting positive to **J6**. Input voltage, including any ripple, must be between the limits of 28 and 44 volts. The power **ON** switch also controls the dc power input.
Turn the power **ON** toggle switch to **ON** and note that the pilot lamp will light when power is applied.

c. **Internal Battery [OPTION MOD-05 and 3015A-MOD 95]**

If the optional rechargeable Ni-Cad battery pack is installed in the instrument simply turn the power **ON** toggle switch to **ON** and note that the pilot lamp lights when power is applied. The pilot lamp serves as a battery charge indicator and if it glows dimly or does not light when the power **ON** toggle switch is turned to **ON**, it indicates that the internal battery is discharged.

To recharge the battery (which should always be done after shipment or storage) set the **BATTERY CHARGE** slide switch (S501) located on the rear panel to **FAST**. Power the instrument either from ac line or an external dc source and turn the power **ON** toggle switch to **ON**. The instrument now functions normally and will also recharge the internal battery. Allow 16 hours **FAST** battery charge to fully recharge a discharged battery. A fully charged battery will power the 3045A for approximately 8 hours.

CAUTION

The internal battery should not be **FAST** charged continuously or its life may be shortened. Avoid **FAST** charge for more than 20 continuous hours. Always keep S501 in **NORM** mode when continuously using external dc or ac line power input to maintain the internal battery fully charged.

3-8. AC VOLTAGE MEASUREMENTS

3-9. The 3045A series of voltmeters are average responding and calibrated in rms of a sine wave. **RMS** calibration is used since rms provides the true measure of power capability or heating value of the input signal waveform.

3-10. If the ac signal under test is not sinusoidal the resulting rms measurement error may be appreciable. The amount of error depends on distortion from sine wave in the input signal and is related to the number of harmonics present as well as their phase relationships. Table 3-2 shows the errors caused by harmonic distortion.

3-11. An unknown input voltage should be checked for waveform distortion on an oscilloscope. Signals which deviate greatly from sine wave shape should be measured with a **TRUE RMS RESPONDING** meter such as the Ballantine 3620A or 323L.

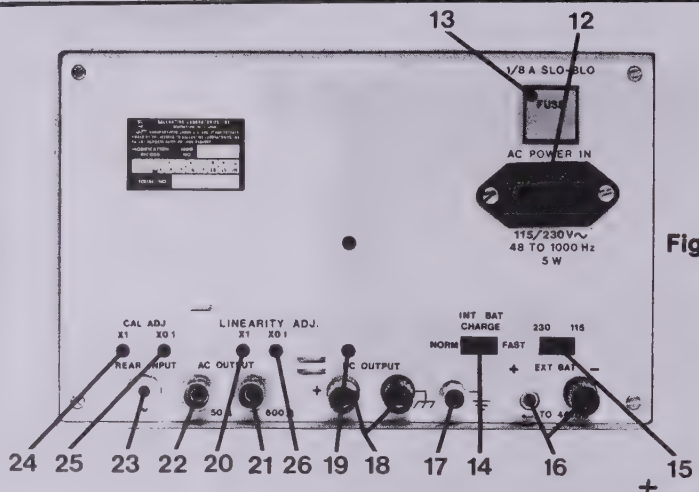


Figure 3-2. Rear Panel Connectors

Figure 3-3. Rear Panel using IEC safety power receptacle.

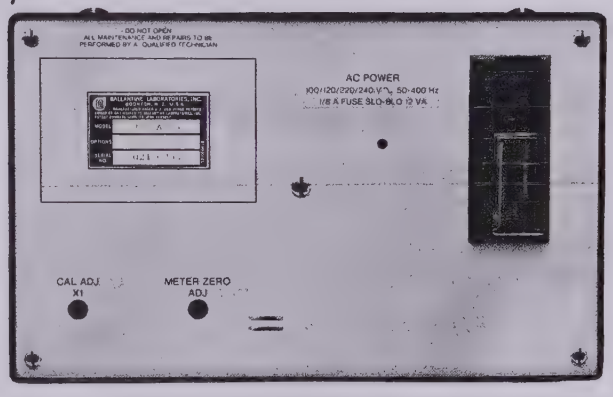


TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO.	Control, Indicator & Connector	Symbol No.	Function
1	3045A Scale	-	Indicates magnitude of applied signal in rms ac volts and dBm. Note linear voltage scale. MOD 30 places dB scale uppermost for greater resolution.
2	Meter Mechanical Zero Adj.	-	Provides mechanical meter zero adjust. Use on 3045A zero based scale ONLY.
3	INPUT Connector	J1	Connects signal to be measured to the voltmeter.
4	RANGE Selector	S1	Selects full scale reading on meter. DB setting of RANGE switch adds directly to dBm reading on scale.
5	RANGE X1 and X0.1 multiplier	S2	Increases RANGE selector by a factor of 1 or 0.1 (+ 20dB). Permits direct scale reading when using ÷ 10 attenuator probes and provides sensitivity to 100uV full scale.
6	L.P. FILTER	S4	Switches 100 kHz filter either in or out of circuit.
7	Power ON Switch	S3	Applies dc power from internal battery or external battery to circuit power supplies. Switch must be ON to recharge batteries. When switch is OFF it places a short across the meter movement during transportation in rugged environments.
8	Power Indicator Lamp	DS1	Indicates application of power to the voltmeter circuits and also serves as internal battery charge indicator when MOD-05 is installed.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO.	Control, Indicator & Connector	Symbol No.	Function
9	3046A Scale		Indicates magnitude of applied signal in dBm and rms ac volts. Note linear dBm scale which permits better resolution on dB readings. 0dBm = 1 mW into 600 Ω.
10	REL. REF. Control 3046A only	R601 / S601	Provides calibrated operation in CAL position and permits continuously variable sensitivity control with -3.2 dBm range to permit measurements against a relative reference.
11	⏚ FLOAT Switch	S10	Screwdriver activated slide switch permits selection of floating "off ground" voltmeter measurements when in FLOAT position and in normal use the ⏚ position ties the shell (signal LO) of the input connector J1 to the case.
12*	Primary ac Power Receptacle	J5	The power cable which provides ac power and "earth" ground is connected through this receptacle.
13*	FUSE	F1	Protects instrument and ac power line against current overload.
14	INT BAT CHARGE Switch (MOD-05 ONLY)	S501	Screwdriver activated slide switch permits 16 hour internal NiCad battery recharge in FAST position and keeps battery fully trickle-charged in NORM position.
15*	Line Voltage Selector Switch	S6	Screwdriver activated slide switch selects 115 or 230 volts ac power line operation. On newer unit printed circuit board switch selects 100/120/220/240 V operation.
16	EXT BAT	J6 (Pos) J7 (Neg)	Binding post terminals for connecting external floating dc power source or battery.
17	Case Ground ⏚ Terminal	J8	Binding post terminal to connect "earth" ground to cabinet case when not using grounded ac primary power input.
18	DC OUTPUT	J9 (Neg) J10 (Pos)	AC to DC converter output. DC voltage is proportional to percentage meter deflection. Output impedance is nominally 500 Ω.
19	DC OUTPUT Adj.	R247	Screwdriver service adjustment sets 1 volt dc output at full scale reading of the meter.
20	METER LINEARITY (X1)	R243	Screwdriver service adjustment sets meter linearity tracking on the X1 range.
21	AC OUTPUT - 600 Ω	J3	BNC connector with shell tied to circuit ground provides ac amplifier 1 volt open circuit output. Output impedance 600 Ω.
22	AC OUTPUT - 50 Ω	J2	BNC connector with shell tied to circuit ground provides AC amplifier 150 mV open circuit output. Output impedance 50 Ω.
23	REAR INPUT (MOD-04 ONLY)	J701	Optional BNC connector with shell tied to circuit ground. Provides for rear entry of input signal in rack mount installations.
24	CAL ADJ X1	R241	Screwdriver service adjustment sets full scale sensitivity on 100 mV range (S1) when RANGE multiplier switch (S2) is in X1 position.
25	CAL ADJ X0.1	R239	Screwdriver service adjustment sets full scale sensitivity on 100 mV range (S1) when RANGE multiplier (S2) is in X0.1 position.
26	METER LINEARITY (X0.1)	R257	Screwdriver service adjustment sets linearity on the X0.1 range.

*Note: Later instruments incorporate IEC safety power receptacle with fuse and 100/120/220/240 Volt Selector Switch.

HARMONIC	% DISTORTION	% ERROR (* Fundamental)	
		MAX. POSITIVE	MAX. NEGATIVE
Any even	0.1	0.000	
	0.5	0.001	
	1.0	0.005	
	2.0	0.020	
Third	0.1	0.033	0.033
	0.5	0.168	0.167
	1.0	0.338	0.328
	2.0	0.687	0.667
Fifth	0.1	0.020	0.020
	0.5	0.101	0.099
	1.0	0.205	0.195
	2.0	0.420	0.380

*Depends on phase relationship between harmonic and fundamental.

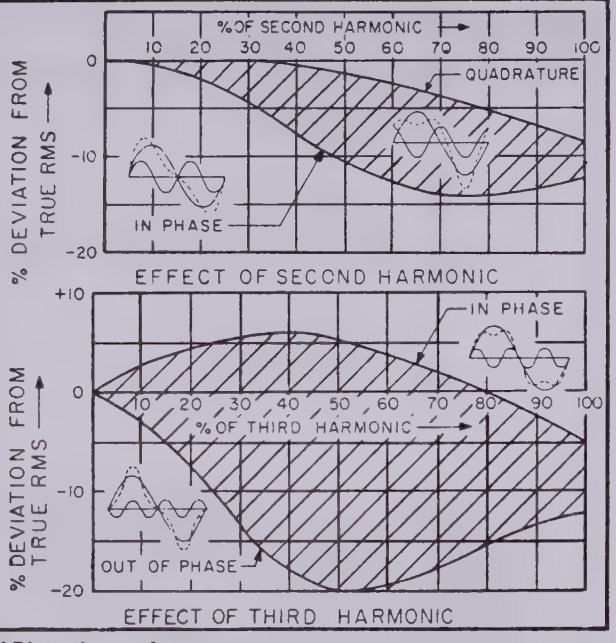


Table 3-2. Effects of Distortion on Accuracy

3-12. Figure 3-5 shows the voltage relationships of a sine wave. For each half cycle

E rms = 0.707 X E Peak

E avg = 0.636 X E peak

Figure 3-5 also provides a simple table for converting any sine wave value to the other values. As an example, simply multiply peak to peak by 0.353 to obtain the rms value.

3-13. SOURCES OF MEASUREMENT ERROR

a. The 3045A series of voltmeters are very wide bandwith instruments with extremely high sensitivity. Great care must be exercised with the input signal connections, especially when low level and high frequency measurements are being made. Use an input divider probe or terminated coaxial connections whenever possible.

b. Care must be exercised by the operator to minimize input test lead capacity to reduce loading of the circuit under test. It is important to maintain the integrity of the voltage during measurement with the voltage existing at the test point when the voltmeter leads are not connected.

c. The input of the 3045A series is 10 Megohms shunted by 24pF (held constant for all ranges when option **MOD-10** is installed). Open wire test leads may add another 25 pF to 50 pF or more if leads are twisted to minimize stray pickup or run over a "ground plane".

d. The loading factor of the total shunt capacity may be determined by the following relationship:

$$Xc\ (Ohms) = \frac{1}{2\pi f_c C}$$

Where f_c is frequency in Hz and C is capacitance in Farads. For example, 50 pF shunt capacitance at 6 MHz is:

$$Xc = \frac{1}{6.28 \times 6 \times 10^6 \times 50 \times 10^{-12}}$$

$$= \frac{1}{6.28 \times 300 \times 10^{-6}} = \frac{1}{1.884 \times 10^{-3}}$$

= 530 Ohms of reactive loading

e. This is very low impedance compared to the 10 Megohm input resistance of the instrument and may present a considerable error by loading the test point. In fact, to achieve less than 1% error in voltmeter reading accuracy due to capacitive loading, the test point source impedance should be less than one one-hundredth of the combined capacitive loading impedance of the voltmeter and test leads. In the foregoing example the test point source impedance should be less than 5.3 Ohms if the measurement error due to capitive loading is to be less than 1% at 6 MHz.

f. The loading effect becomes more important at higher frequencies but is present even at power line frequencies.

g. In addition, ac current will flow thru the test leads because of the lower input impedance of the instrument at higher frequencies. Again referring to the above example and assuming a 10 Volt ac rms signal input, then

$$I = \frac{E}{Xc} = \frac{10V}{530\Omega} = 18\ mA$$

of current **must** be supplied by the test point and flows thru the test leads and the input circuit of the voltmeter at 6 MHz.

h. To minimize capacitive loading and to provide shielding of the input signal test leads use of the Ballantine 10601A divider probe is recommended. This 5 foot long 10:1 divider probe presents a load of approximately 10 MΩ shunted by 15 pF when compensated to the voltmeter input. Multiply the voltmeter sensitivity with the range multiplier toggle switch by setting it to X0.1 when using the divider probe. The meter and **RANGE** Switch will then still be direct reading.

—NOTE—

The Ballantine 12614A adapter is required to match the 10601 probe to the 10 M Ω input resistance of the voltmeter.

i. A 50Ω terminated coaxial input cable is recommended whenever input signals above 1MHz are to be measured. Use of the Ballantine 12631A 50Ω **BNC** feed thru termination is recommended as is the 12249D 120cm long **BNC-BNC** shielded cable. Always place the terminating resistor at the input connector of the voltmeter.

—NOTE—

When using rear panel input connection (option **MOD-04**) always terminate in 50Ω at the **FRONT** panel to avoid increased input capacity loading and transmission line effects. The instrument is calibrated with 50 Ohm source impedance at the front panel.

3-14. Some test points or input connections may exhibit negative reactance when connected to the voltmeter. Oscillations may result which give meter readings even in the absence of an input signal. Avoid inductive or resonant sources and, if necessary, place a small resistor (10Ω to 220Ω) in series with the voltmeter input at the input connector.

3-15. TRANSMISSION LINE ERROR

a. At higher frequencies and when using long lengths of connecting coax cable, calibration errors caused by propagation time delay, and standing waves in unmatched and unterminated systems may result.

b. Always use a matched and terminated coax connecting system to limit transmission line errors.

3-16. GROUND CURRENT ERRORS

3-17. A common source of measurement error in low signal level measurements is extraneous ground current. This ground current is normally a power line current or other frequency not part of the signal to be measured but which flows in the ground lead impedance. This results in an unwanted voltage appearing in addition to the signal at the input **BNC** connector. The effects of such ground currents may be reduced or eliminated by:

a. Employing twisted or coaxial signal leads and keeping these as short and direct as possible.

b. Using only one power line earth return for all the equipment relating to the measurement set up.

c. Eliminating or reducing ground currents where possible. Isolation transformers with low interwinding capacitance, shielding, and high series resistance when connected in power lines are effective in breaking power line and other low frequency ground loops.

d. Making all ground impedances, signal return paths and earth ground impedances as low as possible.

e. Operating the voltmeter on internal batteries (**MOD-05**).

f. Operating the voltmeter from an isolated and floating external battery.

g. Operating the voltmeter with the front panel **FLOAT** slide switch in **FLOAT** position (above 10mV **RANGE**).

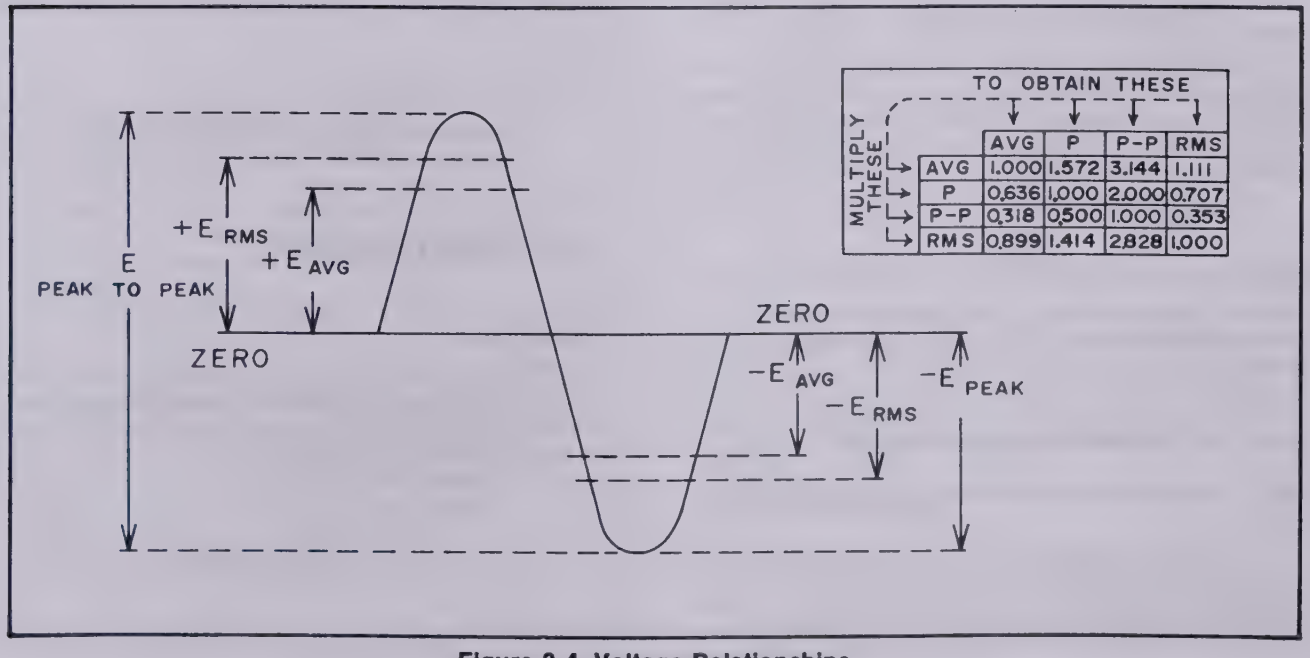


Figure 3-4. Voltage Relationships

3-18. MAGNETIC AND/OR ELECTROSTATIC FIELD ERRORS

3-19. Strong electrostatic and/or magnetic fields close to the signal leads, or to the voltmeter itself may give rise to appreciable measurement errors. Always use shielded or twisted signal input test leads. Avoid running the signal input leads near cables carrying large currents, or close to switching regulators, power transformers, heaters, etc. Avoid proximity to unshielded signal sources such as instruments in plastic cases, unshielded oscilators, signal generators or function generators. **DO NOT** mount the instrument close to magnetic power regulators, motors, switching regulators or other high current or high impulse equipment. In general, effective single or double shielding as well as distance may be used to eliminate errors of this nature.

3-20. INFLUENCE OF AMBIENT TEMPERATURE

3-21. The instrument is usable on **"TURN ON"** and will be within 0.5% of final value within 10 minutes at reference condition.

3-22. The accuracies apply at reference conditions and additional uncertainty of half the accuracy is incurred over the range of +10°C to +40°C and again from 0°C to +55°C.

3-23. OFF GROUND MEASUREMENTS

3-24. Most of the 3045A series voltmeters offer a floating or grounded mode of operation. A slide switch on the front panel is provided to either connect the signal **LO** (**BNC** input connector shell) to the case or to permit the voltmeter circuits to **"FLOAT"** with respect to the case. Off ground measurements may be made up to ±300 volts peak (signal **LO** to case) in the **FLOAT** mode. **DO NOT** use **FLOAT** mode on the 100μV thru 10 mV ranges.

3-25. The **FLOAT** mode permits the voltmeter to measure signals offset on dc voltages and to reduce the effects of unwanted ac voltages which appear "common mode" on both the input signal **HI** and **LO** lines with respect to earth ground.

3-26. The voltmeter may also be floated with nominal shunt capacity to ground (approximately 10 pF on a wooden lab bench and several feet from the nearest metal object) by using floating external battery power or internal batteries (**MOD-05**). When using internal batteries **"OFF LINE"** and **FLOAT** mode, the voltmeter will not respond to off ground dc or common mode ac voltages and will have virtually infinite common mode signal rejection.

3-27. **-WARNING-**

Use care to avoid shock hazard whenever operating the voltmeter without having its case tied to power line earth ground.

3-28. AC VOLTAGE MEASUREMENTS

3-29. Perform the turn on steps listed in paragraphs 3-5 and 3-7.

3-30. Set the meter **RANGE** switch and **RANGE** multiplier to the approximate range to be measured. Set the **L.P. FILTER** to **OFF** unless only signals under 10 kHz are to be measured. In the 3046A, set the **REL REF.** control to **CAL.**

CAUTION

DO NOT APPLY MORE THAN 600 VOLTS TO THE INPUT BNC CONNECTOR OR FLOAT THE INSTRUMENT BY MORE THAN 300 VOLTS. DO NOT OVERLOAD the 100 V to 300 V ranges with signals in excess of 10^7 **VOLT HERTZ** or the 1 volt to 300 volt ranges in excess of 10^8 **VOLT HERTZ**. If any of these overloads are exceeded the instrument may be damaged and the warranty voided.

3-31. If the signal to be measured is a frequency less than 10 kHz, the **L.P. FILTER** may be switched in to filter out signal components over 100 kHz.

3-32. Connect the signal to be measured to the **INPUT BNC CONNECTOR.** The meter will then indicate the rms value of the input sine wave signal.

3-33. NOISE MEASUREMENTS

3-34. For acurate measurements of highly distorted signals or noise, the Ballantine **TRUE RMS** Voltmeter Model 323L is recommended. However, for relative measurements or random (white) noise measurements, the 3045A series can be useful. If the voltage to be measured is white noise with an approximate Gaussian distribution, and the noise bandwidth does not exceed 18MHz, a good approximation to the true rms voltage of the noise input is obtained by adding 13% to the indicated voltage. **DO NOT** overload the amplifiers of the 3045A series with noise and, if possible, take readings only below mid scale meter indication.

3-35. AC CURRENT MEASUREMENTS

3-36. Use Ballantine Series 600 precision shunt resistors to accurately measure AC currents from 100 nA to 10 Amperes. Use the voltmeter in **FLOAT** mode to simplify current measurements. Use Ballantine 12622A **BNC** to dual binding post adapter to match shunts to the **INPUT BNC (J1)** Connector. Contact your Ballantine field engineering representative for information on these shunts and other accessories.

3-37. Always use a minimum resistance non-inductive shunt. Convert the rms voltage meter indications into current by

$$\text{AMPERES} = \frac{\text{METER INDICATION IN VOLTS}}{\text{SHUNT RESISTANCE IN OHMS}}$$

3-38. DB MEASUREMENTS

3-39. Perform the turn on steps listed in paragraphs 3-5, ,3-7 and 3-28.

3-40. The dB measurement is equal to the arithmetic sum of the meter indication, the **RANGE** switch setting and the **RANGE MULTIPLIER** toggle switch setting (**X1** add 0 dB and in **X0.1** add -20 dB). For example:

RANGE switch setting	20dB
RANGE multiplier **X1**	0dB
Meter indication	-5dB
Then the actual dB measurement is	+15 dB.

3-41. The dB scale of the 3045A series is calibrated in dBm. Zero dBm is equivalent to 1 milliwatt dissipated by a 600 Ohm load. Therefore, all dBM measurements must be made across a total load impedance of 600 Ohms. One mW into 600 Ohms will make 0 dBM equate with 0.773 volts. Measurement across all the impedances will be in dB, and not in dBm.

3-42. A reading in dB may be converted to dBm by using the Impedance Correction Graph of Figure 3-6. As an example, to convert a +26 dB reading across 50 Ohms to dBm (referenced to 1 milliwatt) locate the 50 Ohm load impedance line at the left side of the graph. Follow this impedance line to the heavy black line and read the Meter correction in dBm at the intersection point. The correction for 50 Ohms is +11 dBm and the corrected reading for this example is +37 dBm.

3-43. The dB reading may also be converted to other reference levels by using the conversion figures of Table 3-3.

Table 3-3. dB Conversion

REFERENCE LEVEL	dB CONVERSION
1.000V, 1mW in 1000 Ω	Subtract 2.21 dBm
0.775V, 1mW in 600 Ω	Add 0 dBm
0.274V, 1mW in 75 Ω	Add 9.03 dBm
0.224V, 1mW in 50 Ω	Add 10.8 dBm

3-44. The 3046A incorporates a relative reference adjustment. This control permits the meter indication to be continuously varied by more than -3.3 dB.

Use the **REL REF.** control to set the meter at any convenient reference (0 dB for example) to make relative readings easier. When the **REL. REF.** control is in the fully counterclockwise **CAL** position, it has no effect on meter accuracy.

3-45. AC TO DC CONVERTER

3-46. Follow all the turn on steps given in paragraphs 3-29 thru 3-32 for AC voltage measurements.

3-47. Connect the DC output binding posts on the rear panel to a dc measuring device such as a **DVM**, chart recorder limit controller etc. The dc measuring device must have a high input resistance. The DC output resistance of the voltmeter is approximately 500 Ohms. If it is loaded the converter **DC OUTPUT** signal will be inaccurate. A screwdriver accessible DC Adjust control (**R247**) on the rear panel is available to exactly set full scale dc output voltage and match it to the dc measuring device. The output is short circuit protected.

3-48. The DC output is a 0 to 1 volt dc signal proportional to the percentage meter deflection which, of course, is proportional to the average of the ac input signal. The dc output is not affected by the setting of the **REL REF.** control in the 3046A. DC output is 1V at full scale on the 1.0 scale and 0.949 at the 3 mark on the 3 scale of the meter.

3-49. WIDEBAND AC AMPLIFIERS

3-50. The 3045A series of voltmeters provide either one or both ac amplifier outputs of 150 mV from 50 Ohms and 1 V from 600 Ohms (open circuit). A **BNC** connector is provided for each output. Check specifications and the rear panel of your instrument to see which one or if both are supplied. The AC Amplifier may be used as a preamplifier for oscilloscopes, digital counters, limit controllers, etc.

3-51. Follow all the turn on steps given in paragraphs 3-29 thru 3-32 for AC Voltage measurements.

3-52. Connect the signal to be amplified to the **INPUT BNC** Connector **J1.**

3-53. It is permissible to **FLOAT** the instrument for amplifier operation,and to use external dc power or internal battery operation. The shells of the **INPUT BNC** connector and the AC Amplifier **BNC** output connectors are electrically connected together. **DO NOT** use **FLOAT** mode on the 100μV thru 10 mV ranges.

3-54. Observe the same precautions to reduce measurement errors as in voltmeter operation. It is even more desirable in AC Amplifier mode to break the ground loop earth connection through the use of isolating NEMA power cable ground adapters (Ballantine Part Number 31100750) on the oscilloscope, digital counter or other instrument for which the 3045A is used a a preamplifier. Keep input and output leads as short as possible. Shield the input and output leads of the voltmeter to minimize pick up. Keep maximum separation between input and output leads to minimize possible regenerative feedback and oscillations.

3-55. No special consideration need be given to the dc output which may always be used independently of the ac amplifier operation. Nevertheless, it is desirable to place a non-shorting shield cap (Ballantine Part Number 48033250) over the unused amplifier output **BNC** connector. If both 50Ω and 600Ω outputs are provided they may be used to provide separate outputs simultaneously. If both are used and high amplification is employed, use extreme care with input/output shielding and ground currents. Avoid common ground paths which may cause oscillations at higher frequencies.

3-56. The gain of the amplifier depends on the **RANGE** selection and whether the 50 Ohm or 600 Ohm output is used. The **RANGE** multiplier toggle switch changes gain in the AC amplifier mode The open circuit full range output voltage is 150 mV for the 50 Ohm output and 1 Volt for the 600 Ohm output. Table 3-4 shows the ac amplifier gains for each **RANGE** setting.

3.57 USING THE INSTRUMENT TO 10 KILOVOLTS

3-58. The Ballantine 1301B, a 1000:1 capacitive divider probe is rated for 10,000 V rms operation from sine waves beyond 1 MHz. It may be used to extend the input voltage range to 10 kV. Model 1301A has a BNC connector, and Model 1301B is terminated in a double banana plug for the 3015-MOD 95.

3-59. 3045A MOD-30

3-60. Operation of the 3045A with **MOD-30** special scale option is the same as for the standard 3045A. The dB scale reads from -15 to +2 instead of -12 to +2, and is placed at the top of the scales for better resolution. This scale is standard on the 3015A-MOD 95.

Table 3-4. AC Amplifier Gain

RANGE	GAIN	
	50 OHM OUTPUT	60 OHM OUTPUT
100 μV	+ 64 dB	+ 80 dB
300 μV	+ 54 dB	+ 70 dB
1 mV	+ 44 dB	+ 60 dB
3 mV	+ 34 dB	+ 50 dB
10 mV	+ 24 dB	+ 40 dB
30 mV	+ 14 dB	+ 30 dB
100 mV	+ 4 dB	+ 20 dB
300 mV	— 6 dB	+ 10 dB
1 V	—16 dB	0 dB
3 V	—26 dB	—10 dB
10 V	—36 dB	—20 dB
30 V	—46 dB	—30 dB
100 V	—56 dB	—40 dB
300 V	—66 dB	—50 dB

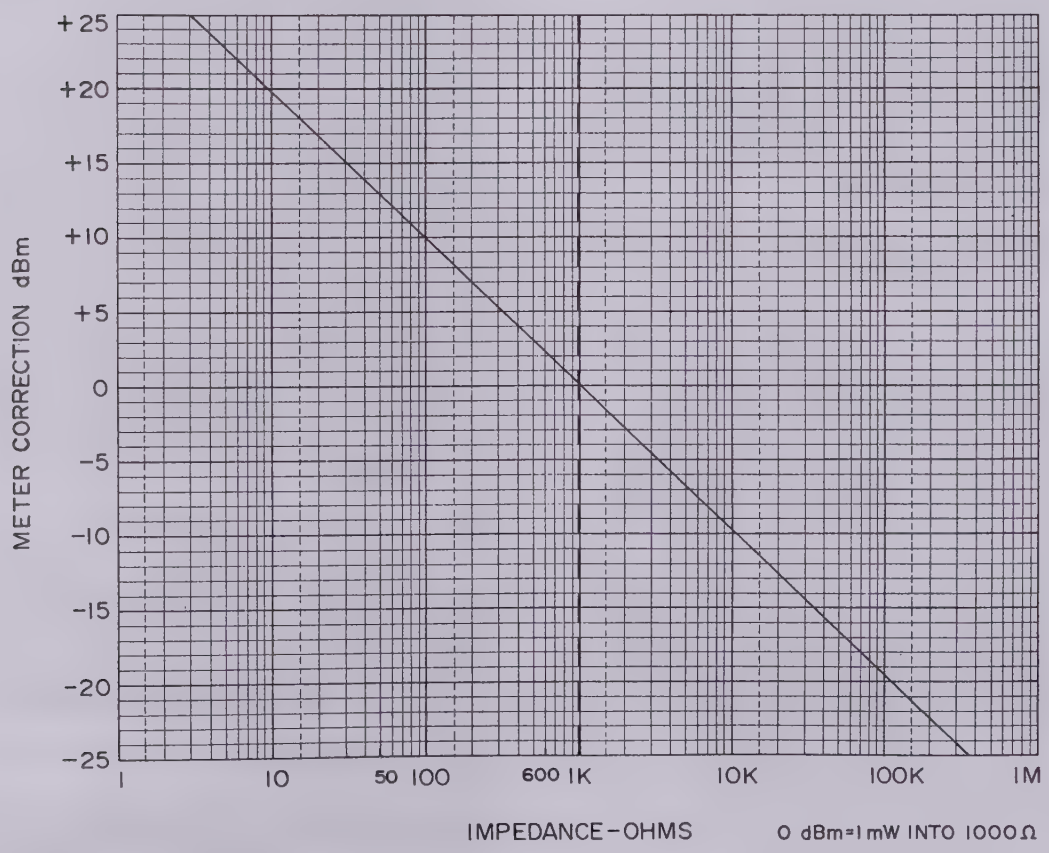


Figure 3-5. Impedance Correction Graph

Section 4

Principles of Operation

4-1. INTRODUCTION

4-2. The 3045A series instruments are solid state average responding voltmeters calibrated in rms of a sine wave. The instrument also may be used as a wide band amplifier and as an ac to dc converter. Figure 4-1 provides a simplified block diagram used for the following discussion.

4-3. When the input attenuator **RANGE** switch **A1S1** is in any of the first six positions (from 1 mV thru 300 mV), the input signal is not attenuated but is directly applied to input **FETA1Q101**. **A1R103, A1C103,** and **A1R104** act as a voltage overload protection network in conjuction with the low capacity protection diodes monolithically incorporated in **A1Q101.** The remaining six positions of the **RANGE** selector switch **A1S1** (from 1V to 300V) insert a 1000 to one (60 dB) attenuator. The low frequency attenuation ratio is adjusted at 1 kHz, by **A1R106** while the high frequency attenuation ratio is adjusted at 100 kHz by **A1C104.** The attenuator is properly shielded and high voltage rated components are used to avoid breakdowns or changes in calibration with voltage overloads.

4-4. The signal from the input attenuator is supplied to the input amplifier. This amplifier is an impedance converting amplifier with a voltage gain of approximately 30 set by feedback resistors **A1R126**, **A1R127** and capacitor **A1C115**. When the **RANGE** selector switch **A1S1** is in the 100 mV, 300 mV, 100V and 300V position a different feedback network consisting of **A1R117** and **A1C111** is used to reduce the voltage gain by ten to one (20dB) to approximately 3. The negative feedback is used to stabilize the amplifier and assure calibrated gain and frequency response over extended environments, components changes and long recalibration intervals. The high input impedance is provided by a protected dual gate **MOS FET A1Q101** which assures low noise, excellent bandwidth and an entry point for dc stabilization. The amplifier is dc coupled throughout, which assures fast recovery from input overloads and ideal low frequency performance. The input amplifier has excellent linearity to avoid introduction of harmonic distortion at higher signal levels and its low output impedance is matched to drive the post attenuator.

4-5. The post attenuator attenuates the output voltage from the input amplifier. See Table 4-1 for details of attenuation vs. **RANGE** switching. **A1R132** adjusts the first step accuracy of the post attenuator (3mV and 3V ranges) to compensate for the output impedance of the input amplifier. The post attenuator is a ladder type constant impedance attenuator. Its characteristic impedance is nominally 500 Ohms and ranging accuracy is maintained with 0.1% precision fixed resistors. **A1R133** maintains constant impedance in the straight thru position while fixed capacitors **A1C131** and **A1C127** maintain constant bandwidth. Full scale voltage output from the post attenuator is nominally 33 mV rms when the range **MULTIPLIERS** is in the **X1** position.

4-6. The output amplifier is a high gain dc coupled dc feedback amplifier. The meter bridge is in the ac feedback path and is dc coupled to the output of the output amplifier. It converts the ac input signal to a dc voltage proportional to the absolute average value of its ac input since the output amplifier presents a high impedance to the meter bridge. The meter bridge differentially drives the meter amplifier. **A1R222** adjusts the dc level of the output amplifier so that the meter bridge drive is centered about the circuit ground. The output amplifier has high feedback and excellent gain - bandwidth so that no gain or frequency adjustments are required.

4-7. The meter amplifier is a monolithic operational amplifier (**A1U201**). Range **MULTIPLIER** switch **A1S2** selects either **X1** or **X0.1** gain in inserting the proper feedback resistor. The amplifier is a low pass filter to eliminate remaining ripple from the meter bridge and to set the meter response time. **A1C222** is the integrating capacitor. Since the meter amplifier is essentially a gain switched dc amplifier with excess feedback, it uniquely contributes to the performance of the instrument by isolating the meter from the meter bridge. The full scale output of the meter amplifier is nominally 2 volts dc and its current capability is sufficient to drive a rugged, high torque 1 mA meter as well as the dc output whose amplitude is set by **A1R247**.

4-8. A three stage AC output amplifier derives its input from the buffered input of the output amplifier. It provides full scale and open circuit 150 mV rms to a 50 Ohm output and one volt rms to a 600 ohm output counter.

4-9. The ac power supply is a transformer input bridge rectifier circuit feeding two 12 Volt monolithic integrated circuit power supply regulators. The latter are wired in series and their junction is circuit ground so as to provide very well regulated, short circuit proof, plus and minus 12 Volt power supplies.

4-10. CIRCUIT DESCRIPTION [See Figures 6-1 through 6-6]

4-11. **Input Attenuator**

4-12. The input attenuator is a 12 position **RANGE** switch (**A1S1**) which is inserted and soldered into the main assembly board (**A1**). The initial six positions are straight thru while the remaining six steps provide attenuation by 1000 (-60 dB). All components in the input circuit are mounted in Teflon or diallylpthalate to optimize the performance of the 10 Megohm attenuator in severe environments and high humidity. See paragraph 4-3 for additional details.

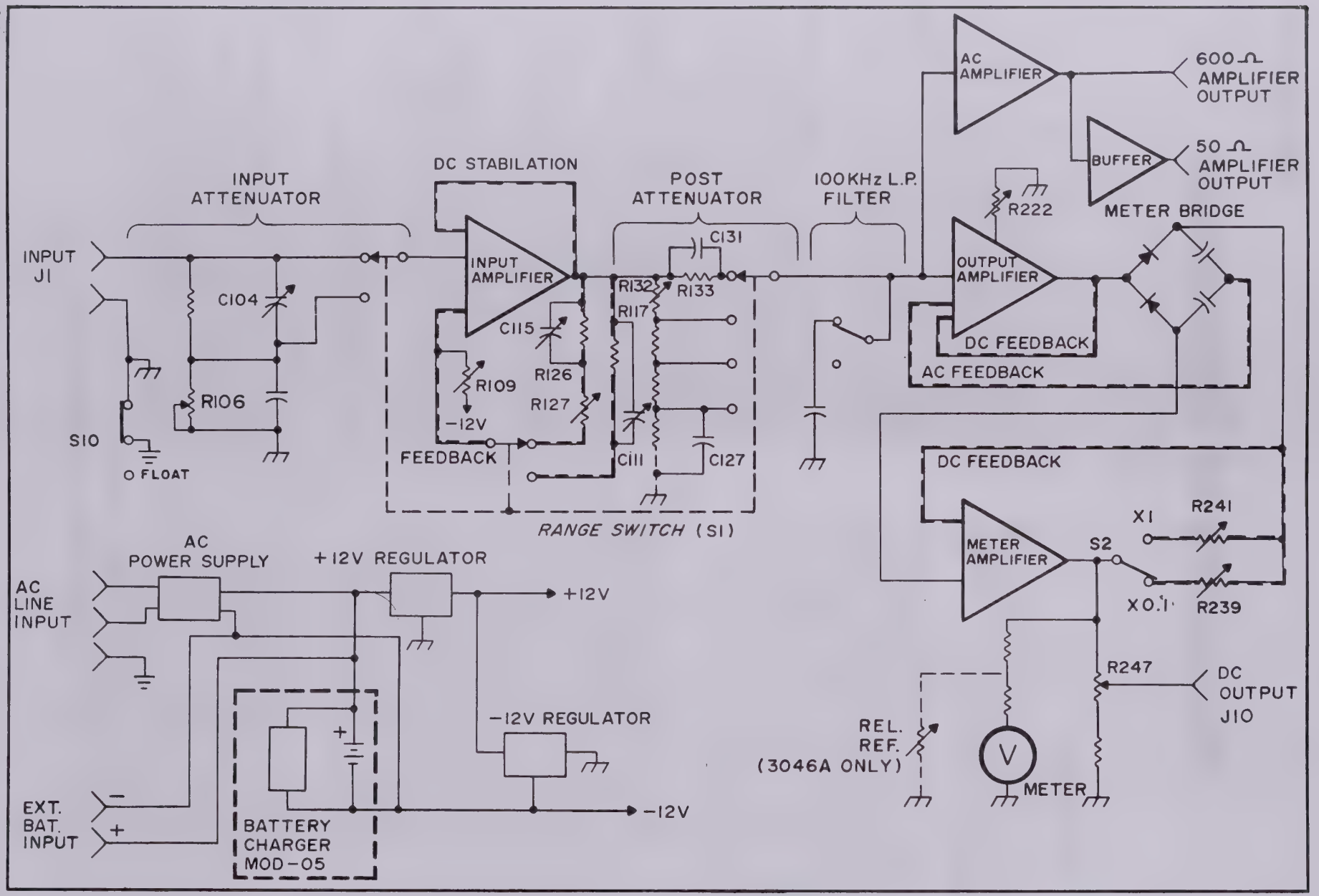


Fig 4-1. Simplified Functional Block Diagram

Table 4-1. Attenuation vs Range Switching

Range	Input Attenuator		Input Amplifier Gain dB	Post Attenuator		Meter Amplifier 3045A and 3046A Multiplier	Total Attenuation dB	
	Ratio	dB		Ratio	dB		3045A 3046A	3015 (3015A MOD-91, 92)
100 μV	1	0	0	1	0	X0.1 (+20dB)	0	N/A
300 μV	1	0	0	.316	-10	X0.1 (+20dB)	-10	N/A
1mV	1	0	0	1	0	X1	-20	0
3mV	1	0	0	.316	-10	X1	-30	-10
10mV	1	0	0	0.1	-20	X1	-40	-20
30mV	1	0	0	.0316	-30	X1	-50	-30
100mV	1	0	-20	0.1	-20	X1	-60	-40
300mV	1	0	-20	.0316	-30	X1	-70	-50
1V	1000	-60	0	1	0	X1	-80	-60
3V	1000	-60	0	.316	-10	X1	-90	-70
10V	1000	-60	0	0.1	-20	X1	-100	-80
30V	1000	-60	0	.0316	-30	X1	-110	-90
100V	1000	-60	-20	0.1	-20	X1	-120	-100
300V	1000	-60	-20	.0316	-30	X1	-130	-110

4-13. INPUT AMPLIFIER AND ATTENUATORS

4-14. The input amplifier is located on the main assembly board **A1** and it (along with the attenuators) has component designators in the 100 number sequence. The input amplifier is a **FET** input feedback amplifier which matches the high impedance of the input attenuator to the relatively low impedance of the post attenuator. Feedback is switched by the **RANGE** switch **A1S1** so as to provide an additional 20 dB of attenuation and thereby limit the dynamic drive required at the post attenuator. Over-voltage protection is provided by **A1R103** and **A1R104** as well as by the 60 dB **RANGE** attenuator inserted in the 1 Volt thru 300 Volt ranges. These components act to drop the voltage limited by breakdown diodes monolithically incorporated in the input **MOS FET A1Q101**.

-NOTE-

If large continuous overloads or high voltage high frequency overloads endanger the voltmeter beyond its specified overvoltage rating then **A1R104** may be replaced by a 1/16 Ampere miniature fuse (Ballantine Part Number 19100160) to protect against destructive overloads.

4-15. A dual gate **MOS FET (A1Q101)** is used in the input stage because of its protected high impedance input, low noise, good frequency response, and its ability to accomodate a dc stabilization input that is fully separated from the high impedance signal input. The **FET** is buffered by emitter follower **A1Q102** which feeds differential amplifier **A1Q103** and **A1Q104**. **A1Q104** supplies a dc source for emitter feedback resistor **A1R121** and its collector provides the dc stabilization voltage for **FET A1Q101**. **A1Q103** feeds output transistor **A1Q105**. **A1R109** adjusts the dc operating point of the input amplifier so that the collector of **A1Q105** provides essentially zero voltage across the switched feedback resistors **A1R117** and the combination of **A1R126** and **A1R127**. Solid heavy lines on the schematic show signal paths while broken lines show the feedback paths.

4-16. The post attenuator is a ladder attenuator of 500 Ohms characteristic impedance. It is ac coupled from the input amplifier by **A1C134** to avoid meter transients when switching between **RANGE** steps. See paragraph 4-5 for additional details.

4-17. A Low Pass Filter may be switched in by **A1S4**. It consists of capacitor **A1C122** which effectively reduces the high frequency bandwidth of the instrument to 100 kHz (-3 dB).

4-18. OUTPUT AMPLIFIER AND METER BRIDGE

4-19. The output amplifier is a high performance feedback stabilized amplifier which operates at a fixed gain on all ranges. It is located on main assembly board **A1** and has component designators in the 200 number sequence. Its input is a differential amplifier consisting of **A1Q201** and **A1Q202**. Signal enters at the base of **A1Q201** while dc feedback is applied to the base of **A1Q202** and ac feedback from the meter bridge is fed into the emitter of **A1Q201**. Signal is taken from the collector of amplifier **A1Q201** and buffered by emitter follower **A1Q203** which feeds the base of **A1Q204**. **A1Q204** and **A1Q205** comprise a differential amplifier. The dc level for the entire output amplifier is adjusted by **A1R222** which sets the base voltage on **A1Q205**. Signal from the collector **A1Q206** drives the average responding meter bridge. Very high source impedance assures absolute average response. It is achieved by the high gain bandwidth of the output amplifier and by including the meter bridge in the ac feedback loop.

4-20. The meter bridge is a typical two diode bridge rectifier. It is driven from a high impedance source and provides a dc output proportional to the absolute average of the input ac waveform.

4-21. Diodes **A1CR201** and **A1CR202** are hot carrier diodes which permit excellent high frequency performance beyond 25 MHz. They have negligible storage time and therefore induce inconsequential phase shift in the ac feedback to the output amplifier. **A1R231** and **A1R232** each develop approximately 150 mV forward bias to linearize the bridge for small input signals. **A1R234** and **A1R235** provide loading for the bridge as well as balance to circuit ground. These load resistors further flatten frequency response. Signal output from the meter bridge is taken from the output of the diodes.

4-22. The meter bridge is included in the ac feedback path of the output amplifier to assure an effective high driving impedance for the rectifier bridge and therefore to make it average responding. The very high feedback factor optimizes rectification linearity over the full frequency and dynamic range. Feedback is taken from the junction of bridge capacitors **A1C217** and **A1C218**.

4-23. METER AMPLIFIER

4-24. The meter amplifier is a high performance monolithic integrated circuit operational amplifier (**A1U201**). It is driven differentially from the two balanced outputs of the meter bridge. The meter amplifier is controlled by negative feedback applied from the amplifier putput to its inverting input. The feedback and input resistors are sufficiently large that the meter amplifier presents negligible loading to the meter bridge to assure optimum rectification linearity.

4-25. The response time of the voltmeter is controlled in the meter amplifier by making it an integrating amplifier. **A1C222** controls the integration time constant and is placed in the negative feedback loop of the meter amplifier.

4-26. The feedback in the meter amplifier is switched by range **MULTIPLIER** switch **S2B** to provide **X1** and **X0.1** multiplication thru a feedback controlled gain change of 20 dB. **A1R241** adjusts the **X1** gain while **A1R239** sets the **X0.1** gain (+20 dB).

4-27. The input bias voltage offset of **A1U201** and the meter bridge is nulled by **A1R243** when the range **MULTIPLIER** is set to **X1** and by **A1R257** when set to **X0.1**. These controls permit adjustment of down scale linearity and tracking.

4-28. Using an op-amp to buffer the meter movement from the bridge rectifier greatly improves the linearity and dynamic range of the bridge rectifier. It also makes available ample driving power for a rugged high torgue 1mA taut-band meter movement and a comparatively low impedance dc converter output which is fully independent of the meter and the other AC amplifier outputs.

4-29. To improve downscale linearity a feedback hold off circuit increases gain in the lower quarter of the **X0.1** range. **ACR203**, **A1R255** and **A1R256** comprise the feedback holdoff which functions until the meter amplifier output voltage increases and **A1CR203** conducts.

4-30. To avoid meter needle slam and meter overloads which might damage the meter movement or deteriorate meter linearity or calibration, Ballantine has engineered a unique circuit which automatically disconnects the meter movement from the meter amplifier when overloads exceed 50% above fullscale (i.e. 1.5mA). **A1CR801** simply disconnects when the voltage drop across **A1R801** begins to back-bias the diode.

4-31 **A1R802** and **A1803** have a resistance many times that of the meter movement and thereby act as a constant current source to the meter which eliminates temperature related calibration errors in the copper wire coil in the meter. **A1CR802** is forward biased by **A1R802** to compensate for forward drop in output diode **A1CR801**. It assures that the meter is at electrical zero when no signal is applied on those ranges above 100mV where amplifier noise does not cause any meter deflection.

4-32. The DC converter output at **J10** is taken from the meter amplifier and adjusted to 1 Volt full scale by **A1R247**.

4-33. The 3046A linear dB scale meter incorporates the **REL. REF.** control. This control (**A1R601**) operates as a shunt to reduce drive only to the meter and continuously varies calibration by as much as -3.3 dB.

4-34. AC OUTPUT AMPLIFIER

4-34. The AC output amplifier provides a 50 Ohm output which provides 150mV rms (open circuit) and a 600 Ohm output providing at least 1 Volt rms (open circuit). The AC amplifier component reference designations are in the 300 number sequence. These components are also located on the main assembly board **A1**.

4-36. The ac signal available at the free collector of **A1Q202** in the output amplifier is buffered by emitter **A1Q303**. (Some instruments omit this buffer while others may omit all or part of the ac output amplifier system.) **A1C303** couples the signal to amplifier **A1Q302**. **A1R310** adjusts the operating level of **A1Q302** and thereby sets the zero volts output level of the 50 Ohm amplifier output **J2. A1R305** in the emitter of **A1Q302** sets the gain of both ac outputs to exceed the minimum limit in the **X1** range **MULTIPLIER** (**A1S2**) position. Some instruments in this series are equipped with **A1S1**, **A1R309**, and **A1C309** which permit a +20 dB (**X10**) gain magnification of the ac output amplifiers to provide full output of +80 dB gain on the 100μV **RANGE.**

4-37. Signal taken from the tap in the collector resistors of **A1Q302** is ac coupled thru **A1C301** to **J3**, the 600 Ohm output. Signal taken from the collector of amplifier **A1Q302** is fed to the base of emitter follower **A1Q301** and after attenuation and leveling by **A1R303**, **A1R302** and **A1R301** is applied to **J2**, the 50 Ohm output. Both outputs are fully independent, each is short circuit proof and both may be used at the same time.

4-38. POWER SUPPLY

4-39. The power supply operates from external ac power, external dc battery or an optional internal battery.

4-40. The power supply provides +12 Volts and -12 Volts. All components for the power supply are located on the main assembly board **A1** and its component designators are in the 400 sequence except components in the single digit series which identify parts location on the rear panel assembly **A2**. **A1U401** and **A1U402** are monolithic integrated circuit power supply regulators which incorporate their own voltage reference as well as thermal and short circuit protection. The +12 Volt regulator (**A1U401**) provides regulated power to the -12 Volt regulator (**A1U402**).

4-41. External dc battery power is coupled directly to the filter at the input of the regulators. The external battery voltage must be greater than 28 Volts and less than 44 Volts. The battery must float in respect to circuit ground. Diodes **A1CR505** and **A1CR506** protect the circuitry against reversed polarity of the external battery. **ON-OFF** switch **S5A** disconnects the external battery when power is turned off.

4-42. AC power input is through power transformer **A1T401**. Its dual primaries permit 115 Volt (parallel connection) or 230 Volt operation (series connection) as selected by switch **A1S6**. The input to **A1T401** is protected by fuse **A2F1** and line filter **A2C1**. Resistor **A2R1** limits line surge effects and may be removed to improve low line voltage regulation in areas where the power line voltage range is normally between 85 Volts and 110 Volts rms. The output of **A1T401** is rectified by diode bridge **A1CR401** and the resultant dc is filtered by **A1C401**, **A1R401** and **A1C402**.

CAUTION

Line power is always connected to **A1T401** even though the power switch is **OFF**. Remove the power cord whenever servicing the instruments to avoid possible personnel hazard.

4-43. Option **MOD-05** provides internal rechargeable battery operation. The battery and charger components are located on main assembly board **A1** and the component designators are in the 500 sequence. **A1B501** is a nickel-cadmium (24 cell) 28 Volt battery. It is charged at a rate determined by the emitter resistance of A1Q501. **A1R502** is adjusted to provide 60 mA to the battery when switch **A1S501** is in the **FAST** position. When switch **S501** is in the **NORM** position **A1R503** is inserted to limit battery trickle charge to about 10 mA. The power switch **A1S5** must be **ON** for all battery charging. The internal battery may be charged from ac line power or an external dc source.

4-44. 3015A-MOD 95 is powered by two internal batteries,, BT1 and BT2, supplying nominal ±12 volts. When fully charged, the instrument will operate continuously for 40 hours on batteries alone. When AC line power is applied through J5, it is stepped down to the appropriate value by A1T401 and rectified by the diode bridge A1CR401. The DC voltage is then filtered by A1C401, A1R401, and A1C402. The smoothed DC voltage is applied across the two batteries, BT1 and BT2 and a constant current network made up of A1Q501 and its associated components. Resistor A1R501 and diodes A1CR501 through A1CR503 maintain a constant voltage across the base emitter junction of A1Q501 and emitter resistor A1R510. This results in a constant current out of the collector of A1Q501 regardless of changes in line voltage or load. When the power switch, 55A, is in the ON position, part of this current operates the meter and part charges the battery. The current is large enough to fully charge the batteries over an extended period of time, but small enough not to damage the batteries by overcharging. When 55A is in the OFF-BAT CHG position, the entire current charges the batteries, and is sufficient to completely charge it in less than 60 hours. When 55A is in the BAT TEST position, the meter, M201, is connected to the batteries, BT1 and BT2, through resistor A1R805. If the meter indication is less than 2.4, with no AC power, the batteries need to be recharged.

CAUTION

Line power is always connected to A1T401, even though the power switch is OFF. Remove the power cord whenever servicing the instrument to avoid possible personal hazard.

4-45. LED DS1, located on the front panel, lights whenever AC power is applied and indicates that the battery is being charged.

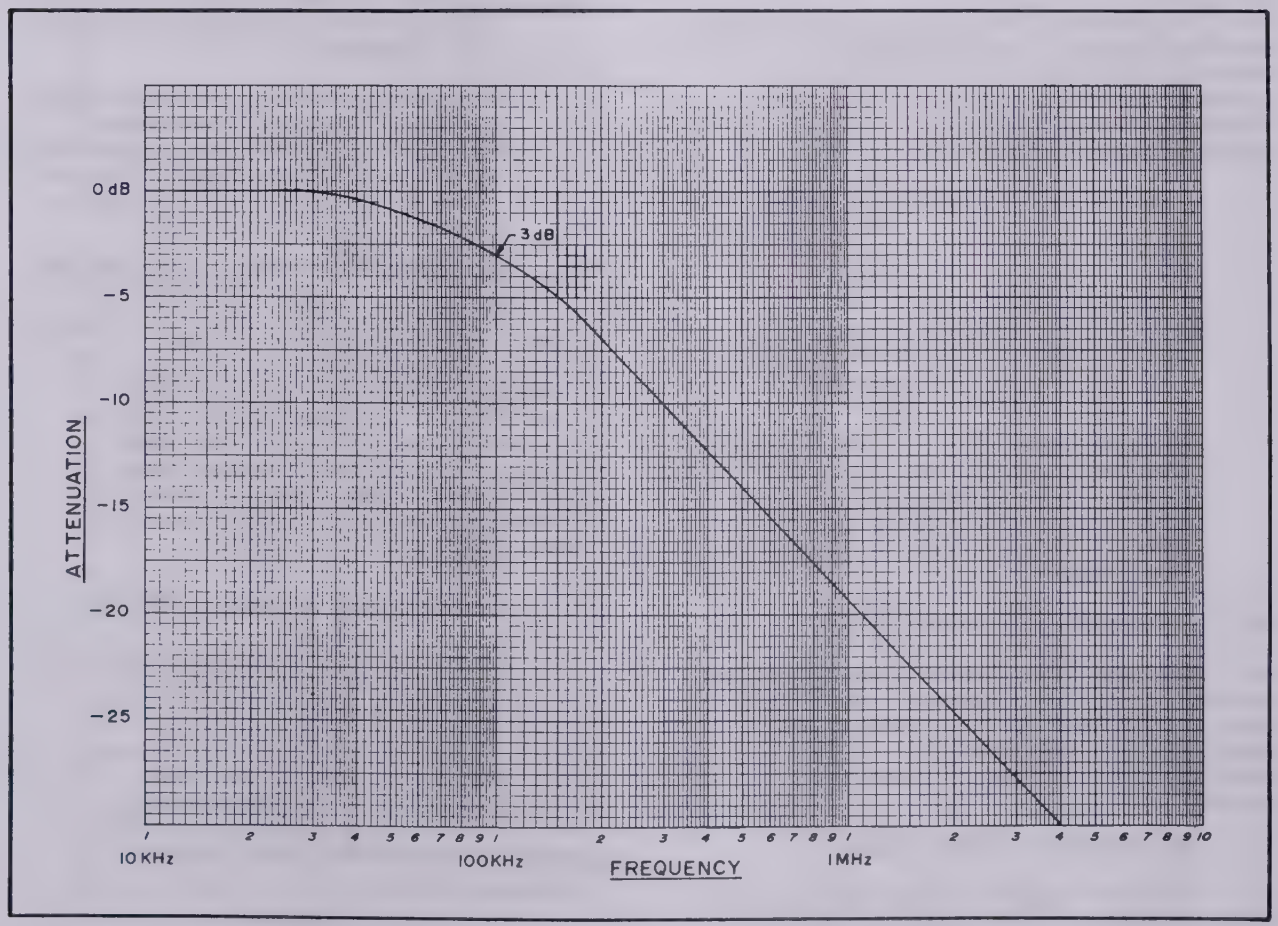


Figure 4-2. 100 kHz Filter Response

Section 5

Maintenance and Calibration

5-1. INTRODUCTION

5-2. This section contains information required to maintain the 3045A series voltmeters within specifications. The following paragraphs detail:

a. Performance Assurance checks

b. Calibration Procedures

c. Fault Finding (Troubleshooting) details

d. Preventive Maintenance

5-3. The 3045A series of instruments are designed with premium components and like other Ballantine instruments will provide many years of satisfactory service. Ballantine recommends that performance assurance checks and preventive maintenance procedures be performed as follows:

a. Routine Laboratory Service- Every 6 months or 1000 hours of use whichever comes first.

b. Service in the field or in extended environments- Every 90 days or 350 hours of use whichever comes first.

Full **NBS** traceable calibration should be performed once a year. Normally the user will provide recalibration services in his plant. If required, Ballantine Laboratories will gladly provide this calibration service at our Boonton, N.J. plant for a nominal charge.

5-4. REQUIRED TEST EQUIPMENT

5-5. Table 5-1 provides a list of required test equipment needed to properly check, calibrate and maintain the 3045A series voltmeters. Equivalent test equipment meeting all the minimum requirements may be substituted if the recommended items are not available.

5-6. MECHANICAL ZERO ADJUST

5-7. Only the zero based linear voltage scale meters of the 3045A, the 3015A and others in this series should be checked for mechanical meter zero adjustment. **DO NOT** adjust the mechanical meter zero setting on the 3046A and other instruments with a linear dB scale since serious miscalibrations and non-linearities can result.

5-8. Before any performance checks are made or calibration is performed in zero based linear voltage scale instruments, readjust the meter mechanical zero adjustment in the following order:

a. The meter mechanical adjustment screw is located centrally on the meter and below the scale. Rotate the screw **CLOCKWISE** until the meter pointer is to the left of zero on the voltage scale and moving upscale toward zero. Be sure the instrument is in its normal operating position.

b. Continue to turn the adjustment screw clockwise and **STOP** when the meter pointer is precisely on the zero mark. If the meter needle goes beyond zero, repeat step a.

c. When the meter pointer is precisely over the zero mark, turn the adjustment screw slightly **COUNTER CLOCKWISE** to back off the tension on the meter taut band suspension. If the pointer moves to the left, repeat all the above steps, but use less counter clockwise rotation.

5-9. PERFORMANCE ASSURANCE CHECKS

5-10. The performance assurance checks are "in cabinet tests that compare the 3045A series with the applicable specifications. A test record form is provided for these instruments. The form included in this manual as Form 5-1 may be duplicated to provide a permanent record of incoming inspection date or of periodic performance assurance checks. These checks should be conducted in their entirety and in order listed below before any attempt is made to calibrate the instrument.

5-11. CALIBRATION ACCURACY CHECK

5-12. The basic accuracy tests are performed at 1 kHz. A sine wave source calibrated in rms is used as a precisely calibrated input signal to the voltmeter. For the preferred test set up see Figure 5-1. The Ballantine 421A AC/DC voltage calibrator has a basic accuracy of 0.2% at 1 kHz rms and exceptional waveform purity with less than 0.3% harmonic distortion. All meter ranges from 100 μV to 1kV full scale may be calibrated with the 421A calibrator.

-NOTE-

For optimum performance let the 421A calibrator and the 3045A series voltmeter under test warm-up for at least on hour.

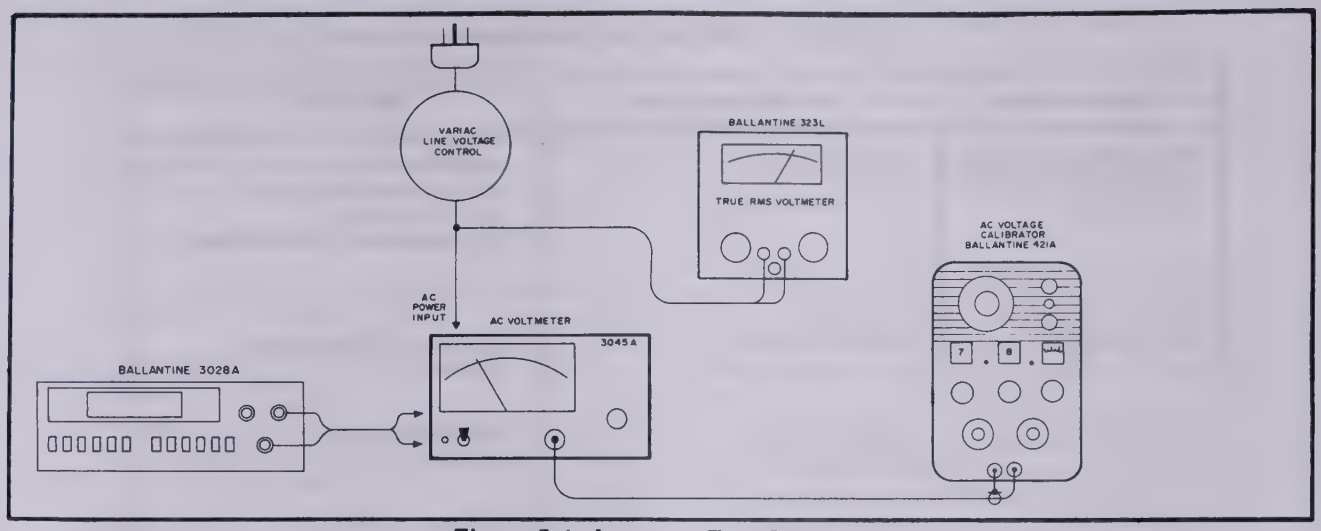


Figure 5-1. Accuracy Test Setup

Table 5-1. Required Test Equipment

Instrument Type	Recommended Model	Specifications
AC Calibrator	Ballantine 421A with 1421 Deviation Calibrator FLUKE 5101B	1 kHz RMS output 1 mV to 1 kV with 4 digit resolution to 1 μV. 0.3% maximum harmonic distortion. Accuracy 0.2% of reading .09%
Test Oscillator Low Frequency	Wavetek 110 or equivalent	1 Hz to 100 kHz Sine wave source 50 Ohm output to 1 V RMS
Test Oscillator Mid Frequency	H-P 651B or 652A or equivalent	10 Hz to 10 MHz 50 Ohm putput to 1 V RMS Distortion ± 0.25%
Test Oscillator High Frequency	Tektronix ~~191~~ SG 503 or equivalent	50 kHz and 350 kHz to ~~100~~ 250 MHz 50 Ohm output to 2 V RMS 4% and 5V peak to peak
Digital Multimeter	Ballantine 3028B	DC: 1000mV to 1 kV Full Scale Accuracy 0.25% Input impedance 10MΩ Current 10 nA to 1 Amp AC: 1000mV to 300V Full Scale Accuracy 1%, 40 Hz to 20 kHz Current 10 nA to 1Amp Ohms: 100 Ohms Full Scale with 0.1Ω resolution to 10 MΩ in 6 decade ranges
Thermal Converter	Ballantine 1394A-1 or 1600A AC/DC Auto-balance Transfer Standard	Input: 0.5V to 1V Frequency Response: DC and 5 Hz to 30 MHz Impedance: 200Ω per volt AC/DC Transfer Accuracy: 0.1% to 1 MHz 0.2% to 20 MHz Output: 7mV DC with 1 Volt (5mA) input Certified: NBS traceable

Table 5-1. Required Test Equipment (continued)

Instrument Type	Recommended Model	Specifications
Lindeck Potentiometer (DC null Meter and bias supply)	Ballantine 1610A	Bias Range: 10 mV Null Accuracy: 2% of F.S. Null Resolution: ± 1 microvolts or 10 μV full scale.
Termination	Ballantine 12630A	50 Ohms, 1W, BNC to BNC feedthru
Adapter (2 ea.)	Ballantine 12620A or equivalent	BNC female to GR-874
Adapter (2 ea.)	Ballantine 12625A or equivalent	BNC male to GR-874
"T" Adapter	Ballantine 10186A or equivalent	GR-874 "T"
Coaxial Attenuator (2 ea.)	Ballantine 12626A or equivalent	50 Ohm, GR-874 20 dB DC to 1 GHz Flatness 0.1% DC to 100MHz
Coaxial Attenuator	Ballantine 12627A or equivalent	50 Ohm GR-874 10 dB DC to 1 GHz Flatness 0.1% DC to 100 MHz
Coaxial Attenuator (3 ea.)	Ballantine 12628A or equivalent	50 Ohm GR-874 3 dB DC to 1 GHz Flatness 0.1% DC to 100 MHz
Resistors	Ballantine P/N 12125000A or Test Fixture Ballantine 12635A	100 kΩ, ±1% RN-60
	Ballantine P/N 12122670A	499 Ω, ±1% RN-60
True RMS Voltmeter	Ballantine 323 L True RMS Voltmeter	Frequency Range: 5 Hz to beyond 20 MHz (3 dB beyond 40 MHz) Sensitivity: 1 mV full scale to 300 V full scale Battery Operation
AC/DC Transfer Standard (Auto balancing)	Ballantine 1600A with Dana 5500 or equal	.25 V to 1 kV in 12 ranges Null resolution: 10ppm Frequency response: 0.01% dc to 20 kHz 0.05% to 100 kHz 0.05% to 1 MHz 0.75% to 10 MHz 5.00% to 30 MHz Certification: NBS traceable AC/DC difference with 6 digit dc digital voltmeter. 100 mV F.S. to 1 kV F.S. Accuracy ±0.01%: NBS traceable calibration.

5-13. Prior to performing accuracy tests connect the test set-up of Figure 5-1 and make the following line voltage checks to be certain that the 3045A series voltmeter has a fully regulating power supply.

a. Set line voltage auto transformer to 115 V (or 230 V if applicable). Measure line voltage with a precision true rms ac voltmeter.

b. Set voltmeter to 1 millivolt full scale sensitivity.

c. Apply .90mV rms of 1 kHz sine wave from the ac calibrator to the voltmeter.

d. Note that the voltmeter indicates a meter reading of nominally 0.9mV.

e. Vary the power line input to the voltmeter to 90 volts (or 180 Volts) and observe that the meter reading has not changed.

f. Vary the power line to 135 volts (or 270 volts) and observe that the meter reading has not changed.

g. Reset the line voltage to mid line of 115 volts (or 230 volts (or 100 volts as applicable. See paragraph 4-42). If any of the above tests can not be satisfactorily performed then further maintenance and full recalibration is required.

5-14. To check full scale calibration of each voltmeter **RANGE** proceed as follows:

a. Use the test set up of Figure 5-1 and position the 421A calibrator to 1.000mV 1 kHz rms.

b. Set the 3045A series voltmeter to the 1mV **RANGE** and note the tolerance listings of Table 5-2.

c. Set the 421A calibrator deviation calculator (Model 2421) to zero and note that the **DVM** reading of the dc converter output voltage is within the tolerances listed in Table 5-2 for the 1mV range. If not adjust the deviation calculator knob a maximum of ± 0.2% to bring the voltmeter under test into calibration by nulling out the possible 0.2% error in the calibrator. Should this bring the instrument into the required tolerances, rotate the outer dial of the deviation calculator to zero. Set the deviation calculator scale to the adjusted knob position.

d. Adjust the deviation calculator until the 3045A series meter reads precisely the applied voltage. Then read the deviation directly from the deviation calculator dial when checking the remaining full scale meter accuracies. Note that the outer ring dial of the deviation calculator has been set to provide zero meter error on the 1 mV range. Check meter error on all other ranges using the deviation calculator set to its adjusted zero reference. Follow Table 5-2 for all accuracy specifications.

e. If a calibrator is used which has no percentage deviation adjustment capability, simply apply the full scale range input voltage called out in Table 5-2 and read meter error directly from the meter scale. If the calibrator has a percentage deviation range but no deviation null adjust (i.e. H-P 745A/746) simply proceed with the technique outlined above and see Table 5-2 for the 1 mV range meter accuracy. If required simply subtract the 1 mV range error from all other measured errors to obtain range tracking accuracies based on a normalized 1 mV range.

5-15. FREQUENCY RESPONSE CHECK

Check full scale, midscale and 1/3 scale tracking.

5-16. Frequency response for the 3045A series is based on the 1 kHz full scale response and all frequency response measurements are ratioed to the 1 kHz accuracy. Use of the ratio technique speeds measurements by avoiding an amplitude calibration set up at each of the various test frequencies.

5-17. To assure best accuracy, Ballantine recommends the use of thermal converters (Ballantine Series 1394A) to control flatness of input frequency to better than 0.5% from 5 Hz to 15 MHz. The 3045A Series voltmeters are calibrated from 5 Hz to 15 MHz and three signal sources are required to cover this range.

a. 5 Hz to 30 Hz - Function Generator
b. 30 Hz to 350 kHz - Audio Oscillator
c. 350 kHz to 15 MHz - Constant Amplitude Signal Generator

—NOTE—

The test oscillator must have very low distortion (less than 1%) when loaded by 50 Ohms and shunted by 30 pF and a 1394A thermal converter having input resistance of 200 Ohms per Volt. A thermal converter is true rms responding while the voltmeter is average responding and therefore reacts differently to distortion. Any distortion present in the test signal will create a calibration error. See paragraph 3-10.

5-18. The 3045A Series are wideband instruments calibrated from a 50 Ohm source impedance. It is important that the 50 Ohm feedthru termination be used directly at the input **BNC** connector (**J1**) of the voltmeter.

5-19. The signal generators used to measure frequency response must deliver 25 mA rms at 1 Volt output. This drives the thermal converter (5 mA full scale) and the 50 Ohm termination. To obtain low output levels, attenuate the 1 Volt (or 3 Volt) signal from the thermal converter with 50 Ohm constant impedance wide band resistive coaxial attenuators. See Figure 5-3 for the test equipment setup and Table 5-3 for attenuator pads to be used with each range.

5-20. Set up the frequency response test equipment per Figure 5-3. Use the 1 kHz 1 Volt calibrator as the signal source. Connect the thermal converter and voltmeter as indicated. Note that the dc output from the thermal converter is in the range of 6 mV to 8 mV. Permit the equipment to stabilize for at least one hour. Resolve the dc output of the thermal converter to 5 microvolts using the (Lindeck potentiometer) of the Ballantine 1610A.

After warmup adjust the 1 kHz calibrator reference signal until the voltmeter and its DC output voltage read exactly full scale. Rebalance (null) the Ballantine 1610A. Maintain this null balance condition throughout the tests for each range to assure constant input signal amplitude as frequency is varied. Adjust the signal source output amplitude to hold the null to within ±5 μV.

CAUTION

Do not over-voltage the thermal converter. Voltages in excess of the rated input voltage will destroy the thermo-element in the thermal converter.

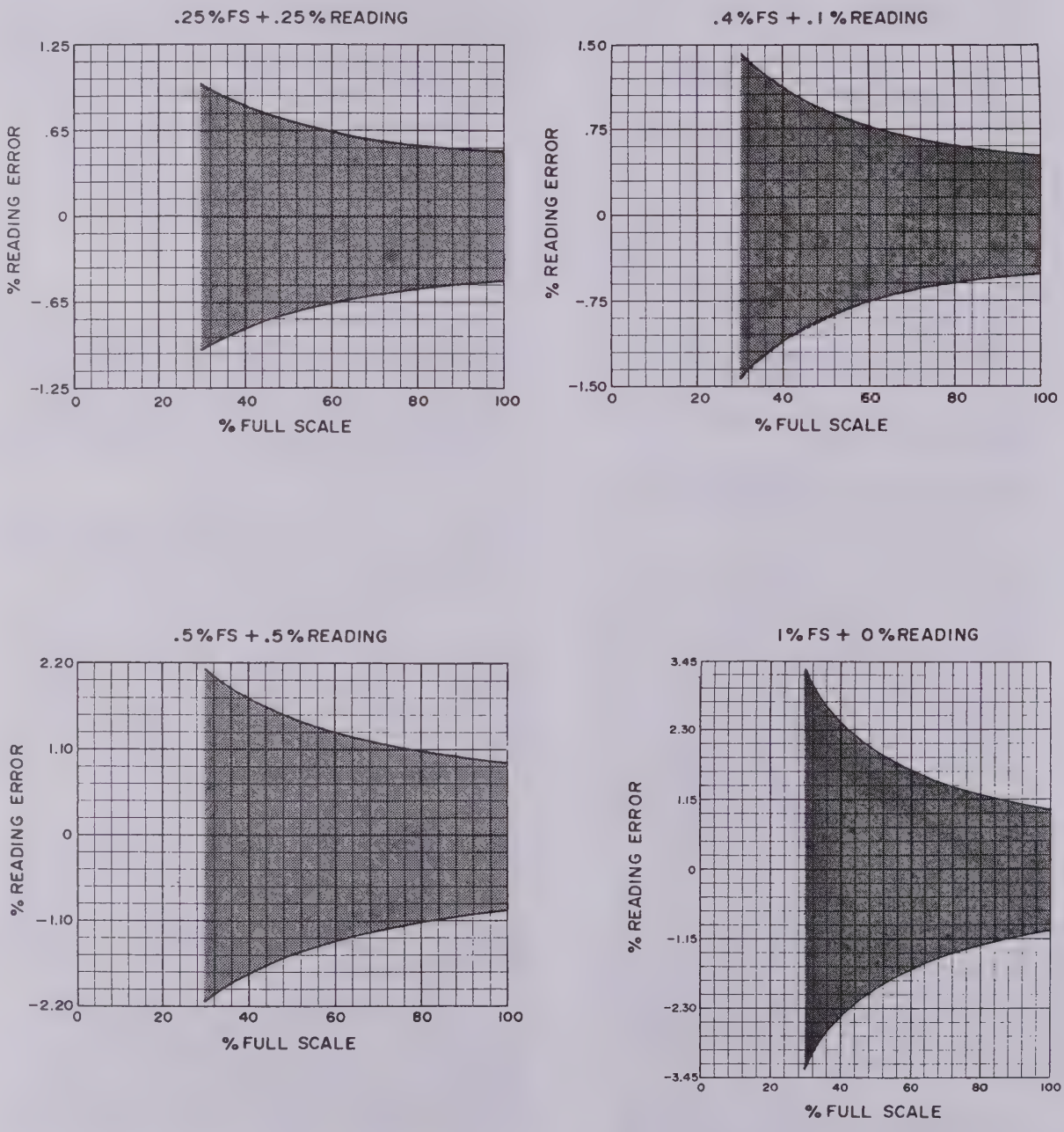
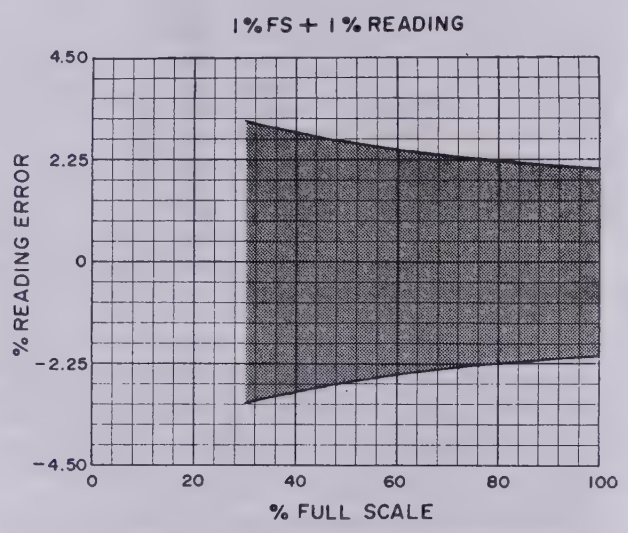
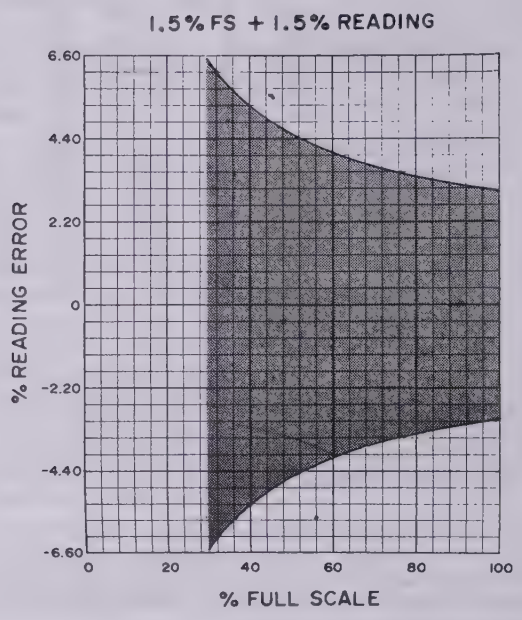
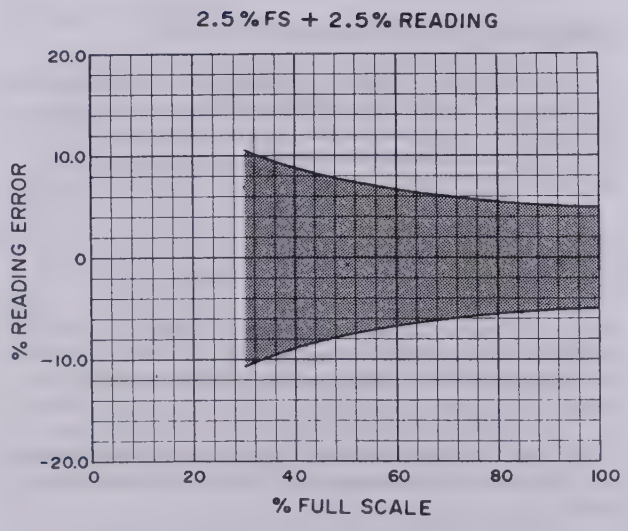


Figure 5-2. Calibration Accuracy Graphs [Sheet 1 of 2]







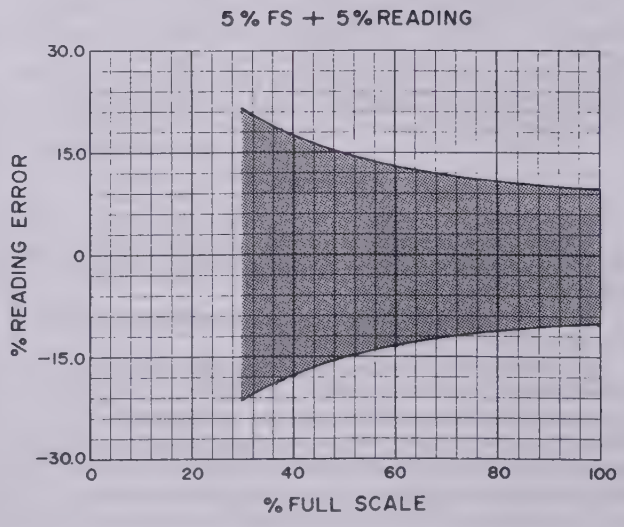


Figure 5-2. Calibration Accuracy Graphs [Sheet 2 of 2]

Table 5-2. 1 kHz Calibration and Ranging Tolerance Check

Calibrator Setting		Voltmeter			
1 kHz RMS	F.S. Multiplier	Range	Multiplier	Meter % of Reading	DC Output [Volts]
1.000	1 mV	1 mV	X0.1	1 ±1%	993 to 1015
10.000	1 mV	1 mV	X1	1 ±1%	995 to 1005
3.000	10 mV	3 mV	X1	3 ±1%	944 to 954
10.000	10 mV	10 mV	X1	1 ±1%	995 to 1005
3.000	100 mV	30 mV	X1	3 ±1%	944 to 954
10.000	100 mV	100 mV	X1	1 ±1%	995 to 1005
3.000	1 mV	300 mV	X1	3 ±1%	944 to 954
10.000	1 V	1 V	X1	1 ±1%	995 to 1005
3.000	10 V	3 V	X1	3 ±1%	944 to 954
10.000	10 V	10 V	X1	1 ±1%	995 to 1005
3.000	100 V	30 V	X1	3 ±1%	944 to 954
10.000	100 V	100 V	X1	1 ±1%	995 to 1005
3.000	1 kV	300 V	X1	3 ±1%	944 to 954

5-21. Check the frequency of the 1 Volt range of the voltmeter as indicated in Table 5-4. Rebalance the null of the thermal converter with the 1 kHz reference at down scale settings of the voltmeter. Be sure to use a 3 dB attenuator pad when checking below half scale.

5-22. Add the required attenuator pads to lower the signal input to the voltmeter. On each range set the 1 kHz calibrator reference to exactly the required scale on the meter and DC output. Then use the offset control to null the Ballantine 1610A. Proceed as indicated in Table 5-4.

5-23. This checks response and calibration at full scale midscale and 1/3 scale for tracking accuracy.

5-24. Normally it is sufficient to check the 1 Volt, 300 mV and 1 mV ranges. Other ranges may be checked at the users option and if the proper test equipment is available. Use signal amplifiers for the normally small signal output level of the oscillators. The H-P 230 and 745/6A are recommended above 10 MHz and to 100 kHz respectively. **Do not** exceed 3 times 10^8 Volt Hertz on the 300 Volt range.

CAUTION

Always use great care when using thermal converters since any overload may destroy the thermoelement. Always use the following precautions:

- Set test oscillator to minimum output amplitude before connecting or disconnecting.
- Set test oscillator to minimum output amplitude before changing frequency range.
- Maintain ground connections in the thermoelement dc output circuit to avoid over voltaging (±50V peak) the junction between the thermoelement heater and couple. Even stray voltages coupled through body capacitance may otherwise breakdown the insulation within the thermoelement.
- Never permit the test oscillator output (rms) to exceed the rating of the thermal converter.

5-25. ABSOLUTE CALIBRATIONS TRACEABLE TO NBS.

5-26. If absolute accuracy calibration is required use a Ballantine 1600A Autobalancing Transfer Standard with a precision DC voltmeter. Use the previous procedure involving the attenuator pads of Table 5-3 and the suggested signal sources. It will not be necessary to normalize the output of the thermal converter. Simply use the 1600A to directly measure the appropriate scale level amplitude settings at different frequencies. See Table 5-4. The 1600A may also be used in the "reverse" mode to set up exactly calibrated test oscillator output signals and error spreads of the voltmeter and its DC output checked against the accuracies of Table 5-4.

5-27. See Figure 5-4 for the test equipment setup using the 1600A Automatic Transfer Standard. This method provides transfer measurement accuracies of 0.01% with a resolution of 10 ppm. Use of the 1600A also permits the most rapid calibration of the 3045A Series voltmeters.

5-28. AC OUTPUT VOLTAGE CHECK

5-29. A 600Ω and a 50Ω AC Amplifier output are provided on the 3045A and 3046A. Only a 50Ω output is provided on the 3015-MOD 91/92 and only a 600Ω output is provided on the 3015A. The X0.1 **Range MULTIPLIER** is provided only on the 3045A and 3046A.

5-30. Connect test oscillator (**HP651**) with frequency range of 10 Hz to 10 MHz to the input **BNC** of the voltmeter. Use a 50 ohm feed thru termination.

5-31. Connect an AC voltmeter (Ballantine 3045A or 323) to the 50Ω AC Output **BNC** Connector thru a very short (< 6 inch) low capacity shielded cable. Set the voltmeter to the 300 mV range.

5-32. Set the voltmeter under test and the oscillator to the one volt range. Set the **Range MULTIPLIER** of the voltmeter to X1.

5-33. Adjust the amplitude of the oscillator for full scale deflection on the 3045 Series Voltmeter. The 50Ω AC Output amplitude should exceed 150 mV rms over the frequency range of 10 Hz to 4 MHz and 135 mV rms to 10 MHz.

5-34. Set the 3045A series voltmeter to **Range MULTIPLIER** X 0.1 and reduce the oscillator output amplitude to full scale meter deflection on the 3045A series voltmeter. The AC output should exceed 150 mV from 20Hz to 2MHz and 115mV from 10 Hz to 6 MHz. 125mV 102mV

Table 5-3

Thermal Converter and Attenuator Pads Per Range

Range	Thermal Converter	50 Ω Attenuator Pads
300V	1600A	None
100V	1600A	None
30V	1600A	None
10V	1600A	None
3V	1394A-5	None
1V	1394A-1	None
300mV	1394A-1	10 dB
100mV	1394A-1	20 dB
30mV	1394A-1	10 dB, 20 dB
10mV	1394A-1	20 dB, 20 dB
3mV	1394A-1	10 dB, 20 dB, 20 dB
1mV	1394A-1	20 dB, 20 dB, 20 dB
100μV	1394A-1	10 dB, 20 dB, 20 dB, 20 dB

USE PROC. FROM 5-30 TO 5-33

5-35. Remove the AC Voltmeter from the 50 Ω AC **OUTPUT BNC J2**. Connect a low-capcitance (10 pF) 10:1 attenuator probe, Ballantine Model 10600, to the AC Voltmeter, through a Ballantine Model 12613A (2 MΩ input) adapter for the Model 323 Voltmeter or a Model 12614A (10 MΩ input) adapter for the Model 3045A Voltmeter. Compensate the probe to the voltmeter using a 400-Hz and a 100-kHz source. Then connect the probe tip and ground clip to the 600Ω AC **OUTPUT BNC J3**.

5-36. Adjust the amplitude of the oscillator to provide full scale deflection (**X1**) on the 3045 series voltmeter 1 volt range. The 600Ω AC Output amplitude should exceed 1 volt rms over the frequency range of 10Hz to 4MHz and 0.8 volts to 10MHz. Repeat with the Voltmeter **Range MULTIPLIER** set to X0.1 and note that the output voltage is greater than 1 Volt rms from 20Hz to 2MHz and 0.75 Volts from 10Hz to 6MHz.

5-37. INPUT IMPEDANCE CHECK

5-38. **Input Capacity Check**

a. Connect a test oscillator to the Input **BNC** of the 3045 Series Voltmeter thru a 100K Ω resistor inserted directly into the **BNC** connector. See Fig. 5-5.

Connect the ground lead from the oscillator to the voltmeter **BNC** shell. Do not add any additional input capacitv bv using an input adapter or holding fixture for the resistor.

b. Set the 3045 Series Voltmeter to the 300 millivolt range and adjust the test oscillator to provide a 300 millivolt full scale reading on the voltmeter at 40 Hz.

c. Increase the frequency of the test oscillator until the voltmeter reads 212 millivolts. This should occur at a frequency of 66 KHz or higher to certify that the input capacity is 24 pF or less on the 300 millivolt range and all ranges to 1 millivolt.

d. Repeat steps b and c with the voltmeter set to 1 volt range. Set the oscillator amplitude to provide full scale meter indication at 40Hz.

e. Increase the frequency of the test oscillator until the 3045A series meter decreases to 707 millivolts. This should occur at a frequency of 72 KHz or higher to certify that the voltmeter input capacity is 22 pF or less on the 1 Volt thru 300 Volt ranges which use the 1000 to one input attenuator.

f. If **Option MOD-10** for constant input capacity is installed in the 3045 Series voltmeter note that the 1 Volt range test of steps d and e above should show 707 millivolts at 64 KHz or higher, and that the frequency reading of steps c and e are within ± 5KHz. This certifies constant input capacity on all ranges from 1mV thru 300 Volts which use the 1:1 and 1000:1 input attenuation steps incorporating input capacity equalization.

5-39. **Input Resistance Check**

a. Connect the test oscillator to the input **BNC** of the 3045 Series voltmeter. Use the 50 ohm output of the oscillator.

b. Set the oscillator and the voltmeter to the 1 Volt range. Adjust the output amplitude of the test oscillator for a full scale meter indication on the voltmeter.

c. Connect a 100KΩ resistor between the oscillator and the input **BNC** as shown in Fig. 5-5.

d. The 3045 Series voltmeter indication should not decrease more than one per cent. This certifies that the voltmeter input resistance is 10 megohms (100 KΩ is 1% of 10 MΩ) on the 1 Volt thru 300V ranges.

e. Repeat steps b, c and d on the 300 millivolt range to certify that the input resistance is 10 megohms on the 1 millivolt thru 300 millivolt ranges.

5-40. AC to DC CONVERTER OUTPUT IMPEDANCE CHECK

5-41. Connect the 50Ω output of the test oscillator to the input **BNC** of the 3045A series voltmeter. Use a 50Ω termination at the input **BNC**.

5-42. Connect a dc digital voltmeter or multimeter to the dc output binding posts on the rear of the 3045A series voltmeter. Set the digital voltmeter to the 1000 millivolt range.

5-43. Set the 3045A series voltmeter to the 1 volt range. Set the oscillator frequency to 100 kHz and adjust the oscillator output amplitude to provide a reading of 1000 millivolts on the dc digital voltmeter.

5-44. Shunt a 499 ohm ± 1% film resistor across the DC output of the 3045A series voltmeter. The voltage read on the digital meter should read between 450 and 550 millivolts to certify that the output impedance is 500 ohms ±10%.

5-45. LINE VOLTAGE RANGE CHECK

5-46. Connect line power to the 3045A series voltmeter thru a line voltage auto transformer (Variac). Measure the line voltage to the voltmeter with a true rms voltmeter. Set the line voltage to 115 (230) volts.

5-47. Connect a test oscillator to the input **BNC** of the 3045A series voltmeter and set both to the 1 Volt range.

5-48. Adjust the test oscillator output amplitude to provide a reading of 0.9 volts on the 3045A series voltmeter.

5-49. Slowly vary the frequency of the test oscillator from 45 to 1000 Hz and note that the voltmeter does not "swing" more than 1% as the oscillator frequency approaches the power line frequency or its harmonics. This checks ripple interference from the power supply.

Table 5-4A Frequency Response Tolerance for 3045A

Frequency [Hz]	1 VOLT RANGE			300 mV RANGE		
	Input [Volts]	Meter [% of Reading]	DC Output [Volts]	Input [m Volts]	Meter [% of Reading]	DC Output [Volts]
1K	1.00	1.00 ± 1 % (REF)	1.00 ± 0.005	300	3.00 ± 1 % (REF)	0.949 ± 0.0047
5	1.00	1.00 ± 10 %	1.00 ± 0.050	300	3.00 ± 10 %	0.949 ± 0.0470
20	1.00	1.00 ± 2 %	1.00 ± 0.020	300	3.00 ± 2 %	0.949 ± 0.0094
100K	1.00	1.00 ± 1 %	1.00 ± 0.005	300	3.00 ± 1 %	0.949 ± 0.0047
1.5M	1.00	1.00 ± 1 %	1.00 ± 0.050	300	3.00 ± 1 %	0.949
4M	1.00	1.00 ± 3 %	1.00 ± 0.050	300	3.00 ± 3 %	0.949 ± 0.0470
10M	1.00	1.00 ± 5 %	1.00 ± 0.050	300	3.00 ± 5.0 %	0.949 ± 0.0470
15M	1.00	1.00 ± 10 %	1.00 ± 0.100	300	3.00 ± 10.0 %	0.949 ± 0.0949
1K	0.50	0.50 ± 2 % (REF)	0.50 ± 0.038	200	2.00 ± 1.58 % (REF)	0.633 ± 0.0040
20	0.50	0.50 ± 4 %	0.50 ± 0.015	200	2.00 ± 6.3 %	0.633 ± 0.0080
1.5M	0.50	0.05 ± 2 %	0.50 ± 0.035	200	2.00 ± 1.58 %	0.633 ± 0.0040
4M	0.50	0.50 ± 4.5 %	0.50 ± 0.035	200	2.00 ± 3.8 %	0.633 ± 0.0450
10M	0.50	0.50 ± 7.5 %	0.50 ± 0.035	200	2.00 ± 6.3 %	0.633 ± 0.0400
15M	0.50	0.50 ± 15 %	0.50 ± 0.075	200	2.00 ± 12.6 %	0.633 ± 0.0810
1K	0.30	0.30 ± 3.3 % (REF)	0.30 ± 0.003	100	1.00 ± 3.1 % (REF)	0.316 ± 0.0032
20	0.30	0.30 ± 6.5 %	0.30 ± 0.012	100	1.00 ± 6.0 %	0.316 ± 0.0405
1.5M	0.30	0.30 ± 3.3 %	0.30 ± 0.030	100	1.00 ± 3.1 %	0.316 ± 0.0032
4M	0.30	0.30 ± 6.5 %	0.30 ± 0.030	100	1.00 ± 6.0 %	0.316 ± 0.0316
10M	0.30	0.30 ± 10.8 %	0.30 ± 0.030	100	1.00 ± 10.0 %	0.316 ± 0.0316
15M	0.30	0.30 ± 21.6 %	0.30 ± 0.036	100	1.00 ± 20.0 %	0.316 ± 0.0632

Table 5-4B Frequency Response Tolerance for 3046A

Frequency [Hz]	1 VOLT RANGE			300 mV RANGE		
	Input [Volts]	Meter [% of Reading]	DC Output [Volts]	Input [m Volts]	Meter [% of Reading]	DC Output [Volts]
1K	1.00	1.00 ± 1.0 % (REF)	1.00 ± 0.005	300	3.00 ± 1.0 % (REF)	0.949 ± 0.0047
5	1.00	1.00 ± 10.0 %	1.00 ± 0.050	300	3.00 ± 10.0 %	0.949 ± 0.0470
20	1.00	1.00 ± 2.0 %	1.00 ± 0.020	300	3.00 ± 2.0 %	0.949 ± 0.0094
100K	1.00	1.00 ± 1.0 %	1.00 ± 0.005	300	3.00 ± 1.0 %	0.949 ± 0.0047
1.5M	1.00	1.00 ± 1.0 %	1.00 ± 0.050	300	3.00 ± 1.0 %	0.949 ± 0.0470
4M	1.00	1.00 ± 3.0 %	1.00 ± 0.050	300	3.00 ± 3.0 %	0.949 ± 0.0470
10M	1.00	1.00 ± 5.0 %	1.00 ± 0.050	300	3.00 ± 5.0 %	0.949 ± 0.0470
15M	1.00	1.00 ± 10.0 %	1.00 ± 0.100	300	3.00 ± 10.0 %	0.949 ± 0.0949
1K	0.50	0.50 ± 1.0 % (REF)	0.50 ± 0.038	200	2.00 ± 1.0 % (REF)	0.633 ± 0.0040
20	0.50	0.50 ± 2.0 %	0.50 ± 0.015	200	2.00 ± 2.0 %	0.633 ± 0.0080
1.5M	0.50	0.50 ± 1.0 %	0.50 ± 0.035	200	2.00 ± 1.0 %	0.633 ± 0.0040
10M	0.50	0.50 ± 5.0 %	0.50 ± 0.035	200	2.00 ± 5.0 %	0.633 ± 0.0400
15M	0.50	0.50 ± 10.0 %	0.50 ± 0.075	200	2.00 ± 10.0 %	0.633 ± 0.0810
1K	0.30	0.30 ± 1.0 % (REF)	0.30 ± 0.003	100	1.00 ± 1.0 % (REF)	0.316 ± 0.0032
20	0.30	0.30 ± 2.0 %	0.30 ± 0.012	100	1.00 ± 2.0 %	0.316 ± 0.0405
1.5M	0.30	0.30 ± 1.0 %	0.30 ± 0.030	100	1.00 ± 1.0 %	0.316 ± 0.0032
4M	0.30	0.30 ± 3.0 %	0.30 ± 0.030	100	1.00 ± 3.0 %	0.316 ± 0.0316
10M	0.30	0.30 ± 5.0 %	0.30 ± 0.030	100	1.00 ± 5.0 %	0.316 ± 0.0316
15M	0.30	0.30 ± 10.0 %	0.30 ± 0.036	100	1.00 ± 10.0 %	0.316 ± 0.0632

Table 5-4C Frequency Response Tolerance for 3015A

Frequency [Hz]	1 VOLT RANGE		300 mV RANGE	
	Input [Volts]	Meter [% of Reading]	Input [m Volts]	Meter [% of Reading]
1K	1.00	1.00 ± 2.0 % (REF)	300	3.00 ± 2.10 % (REF)
10	1.00	1.00 ± 5.0 %	300	3.00 ± 5.27 %
40	1.00	1.00 ± 2.0 %	300	3.00 ± 2.10 %
100K	1.00	1.00 ± 2.0 %	300	3.00 ± 2.10 %
1M	1.00	1.00 ± 3.0 %	300	3.00 ± 5.27 %
2M	1.00	1.00 ± 5.0 %	300	3.00 ± 5.27 %
6M	1.00	1.00 ± 6.0 %	300	3.00 ± 6.32 %
1K	0.50	0.50 ± 4.0 % (REF)	200	2.00 ± 3.16 %
10	0.50	0.50 ± 10.0 %	200	2.00 ± 7.89 %
40	0.50	0.50 ± 4.0 %	200	2.00 ± 3.16 %
100K	0.50	0.50 ± 4.0 %	200	2.00 ± 3.16 %
1M	0.50	0.50 ± 10.0 %	200	2.00 ± 4.74 %
2M	0.50	0.50 ± 6.0 %	200	2.00 ± 7.89 %
6M	0.50	0.50 ± 12.0 %	200	2.00 ± 9.48 %
1K	0.30	0.30 ± 6.0 % (REF)	100	1.00 ± 6.34 %
10	0.30	0.30 ± 15.0 %	100	1.00 ± 15.80 %
40	0.30	0.30 ± 6.0 %	100	1.00 ± 6.34 %
100K	0.30	0.30 ± 6.0 %	100	1.00 ± 6.34 %
1M	0.30	0.30 ± 9.0 %	100	1.00 ± 9.49 %
2M	0.30	0.30 ± 15.0 %	100	1.00 ± 15.80 %
6M	0.30	0.30 ± 18.0 %	100	1.00 ± 18.90 %

Table 5-4D Frequency Response Tolerance for 3015A MOD-91

Frequency [hz]	1 VOLT RANGE			300 mV RANGE		
	Input [Volts]	Meter [% of Reading]	DC Output [Volts]	Input [m Volts]	Meter [% of Reading]	DC Output [Volts]
1K	1.00	1.00 ± 1.0 % (REF)	1.00 ± 0.01	300	3.00 ± 1.05 % (REF)	0.949 ± 0.01
10	1.00	1.00 ± 5.0 %	1.00 ± 0.05	300	3.00 ± 5.25 %	0.949 ± 0.05
40	1.00	1.00 ± 1.0 %	1.00 ± 0.01	300	3.00 ± 1.05 %	0.949 ± 0.01
2M	1.00	1.00 ± 1.0 %	1.00 ± 0.01	300	3.00 ± 1.05 %	0.949 ± 0.01
4M	1.00	1.00 ± 3.0 ⅔	1.00 ± 0.03	300	3.00 ± 3.15 %	0.949 ± 0.03
4M	1.00	1.00 ± 3.0 %	1.00 ± 0.03	300	3.00 ± 5.25 %	0.949 ± 0.05
10M	1.00	1.00 ± 5.0 %	1.00 ± 0.05	300	3.00 ± 5.25 %	0.949 ± 0.05
1K	0.50	0.50 ± 2.0 % (REF)	0.50 ± 0.01	200	2.00 ± 1.58 % (REF)	0.633 ± 0.01
10	0.50	0.50 ± 2.0 %	0.50 ± 0.05	200	2.00 ± 7.87 %	0.633 ± 0.05
40	0.50	0.50 ± 2.0 %	0.50 ± 0.01	200	2.00 ± 1.58 %	0.633 ± 0.01
2M	0.50	0.50 ± 2.0 %	0.50 ± 0.01	200	2.00 ± 1.58 %	0.633 ± 0.01
4M	0.50	0.50 ± 6.0 %	0.50 ± 0.03	200	2.00 ± 4.73 %	0.633 ± 0.03
10M	0.50	0.50 ± 10.0 %	0.50 ± 0.05	200	2.00 ± 7.87 %	0.633 ± 0.05
1K	0.30	0.30 ± 3.0 % (REF)	0.30 ± 0.01	100	1.00 ± 3.16 % (REF)	0.316 ± 0.01
10	0.30	0.30 ± 15.0 %	0.30 ± 0.05	100	1.00 ± 15.80 %	0.316 ± 0.05
40	0.30	0.30 ± 3.0 %	0.30 ± 0.01	100	1.00 ± 3.16 %	0.316 ± 0.01
2M	0.30	0.30 ± 3.0 %	0.30 ± 0.01	100	1.00 ± 3.16 %	0.316 ± 0.01
4M	0.30	0.30 ± 9.0 %	0.30 ± 0.03	100	1.00 ± 9.46 %	0.316 ± 0.03
10M	0.30	0.30 ± 15.0 %	0.30 ± 0.05	100	1.00 ± 15.80 %	0.316 ± 0.05

Table 5-4E Frequency Response Tolerance for 3015A MOD-92

Frequency [Hz]	1 VOLT RANGE			300 mV RANGE		
	Input [Volts]	Meter [% of Reading]	DC Output [Volts]	Input [m Volts]	DC Output [% of Reading]	DC Output [Volts]
1K	1.00	1.00 ± 1.0 % (REF)	1.00 ± 0.01	300	3.00 ± 1.05 % (REF)	0.949 ± 0.01
10	1.00	1.00 ± 4.0 %	1.00 ± 0.04	300	3.00 ± 4.21 %	0.949 ± 0.04
20	1.00	1.00 ± 2.0 %	1.00 ± 0.02	300	3.00 ± 2.10 %	0.949 ± 0.02
50	1.00	1.00 ± 1.0 %	1.00 ± 0.01	300	3.00 ± 1.05 %	0.949 ± 0.01
1M	1.00	1.00 ± 1.0 %	1.00 ± 0.01	300	3.00 ± 1.05 %	0.949 ± 0.01
4M	1.00	1.00 ± 2.0 %	1.00 ± 0.02	300	3.00 ± 2.10 %	0.949 ± 0.02
1K	0.50	0.50 ± 2.0 % (REF)	0.50 ± 0.01	200	2.00 ± 1.58 % (REF)	0.633 ± 0.01
10	0.50	0.50 ± 8.0 %	0.50 ± 0.04	200	2.00 ± 6.32 %	0.633 ± 0.04
20	0.50	0.50 ± 4.0 %	0.50 ± 0.02	200	2.00 ± 3.16 %	0.633 ± 0.02
50	0.50	0.50 ± 2.0 %	0.50 ± 0.01	200	2.00 ± 3.16 %	0.633 ± 0.01
1M	0.50	0.50 ± 2.0 %	0.50 ± 0.01	200	2.00 ± 3.16 %	0.633 ± 0.01
4M	0.50	0.50 ± 4.0 %	0.50 ± 0.02	200	2.00 ± 3.16 %	0.633 ± 0.02
1K	0.30	0.30 ± 3.0 % (REF)	0.30 ± 0.01	100	1.00 ± 3.16 % (REF)	0.316 ± 0.01
10	0.30	0.30 ± 12.0 %	0.30 ± 0.04	100	1.00 ± 12.70 %	0.316 ± 0.04
20	0.30	0.30 ± 3.0 %	0.30 ± 0.01	100	1.00 ± 6.33 %	0.316 ± 0.02
50	0.30	0.30 ± 3.0 %	0.30 ± 0.01	100	1.00 ± 3.16 %	0.316 ± 0.01
1M	0.30	0.30 ± 3.0 %	0.30 ± 0.01	100	1.00 ± 3.16 %	0.316 ± 0.01
4M	0.30	0.30 ± 6.0 %	0.30 ± 0.02	100	1.00 ± 6.33 %	0.316 ± 0.02

Table 5-4F Frequency Response Tolerance X.1 Multiplier

Frequency [Hz]	100 μV Range and X.1 Multiplier			300 μV Range and X.1 Multiplier		
	Input [μ Volts]	Meter [% of Reading]	DC Output [Volts]	Input [μ Volts]	Meter [% of Reading]	DC Output [Volts]
1K	100	1 ± 2.0% (REF)	1.00 ±0.0006	300	3.00 ± 2.1% (REF)	.949 ±0.006
10	100	1 ±10.0%	1.00 ±0.0500	300	3.00 ±10.5%	.949 ±0.05
20	100	1 ± 4.0%	1.00 ±0.02	300	3.00 ± 4.2%	.949 ±0.020
60	100	1 ± 2.0%	1.00 ±0.0200	300	3.00 ± 2.1%	.949 ±0.02
100K	100	1 ± 2.0%	1.00 ±0.006	300	3.00 ± 2.1%	.949 ±0.006
500K	100	1 +2.0% −3.5%	1.00 ±0.015	300	3.00 +2.1% −3.7%	.949 ±0.015
6M	100	1 +3.5% −5.0%	1.00 ±0.05	300	3.00 +3.7% −5.3%	.949 ±0.05
1k	50	1 ± 3.0% (REF)	0.50 ±0.0053	200	2.00 ± 2.2% (REF)	.633 ±0.012
10	50	1 ±15.0%	0.50 ±0.038	200	2.00 ±10.9%	.633 ±0.043
20	50	1 ± 6.0%	0.50 ±0.015	200	2.00 ± 4.2%	.633 ±0.022
60	50	1 ± 3.0%	0.50 ±0.015	200	2.00 ± 2.2%	.633 ±0.022
100K	50	1 ± 3.0%	0.50 ±0.0053	200	2.00 ± 2.2%	.633 ±0.013
500K	50	1 +3.0% −4.5%	0.50 ±0.0125	200	2.00 +2.2% −3.2%	.633 ±0.018
6M	50	1 +6.0% −7.5%	0.50 ±0.0375	200	2.00 +4.58% −5.65%	.633 ±0.042

Table 5-4G Frequency Response Tolerance for 3015A MOD-95

Frequency [Hz]	1 VOLT RANGE		300 mV RANGE	
	INPUT [Volts]	METER READING	INPUT [m Volts]	METER READING
1K	1.00	.98 – 1.02 (REF)	300	294 – 306 (REF)
10	1.00	.98 – 1.02	300	294 – 306
50	1.00	.98 – 1.02	300	294 – 306
100	1.00	.98 – 1.02	300	294 – 306
1M	1.00	.98 – 1.02	300	294 – 306
2M	1.00	.95 – 1.05	300	284 – 316
1K	0.50	.48 – .52 (REF)	200	194 – 206 (REF)
10	0.50	.48 – .52	200	194 – 206
50	0.50	.48 – .52	200	194 – 206
100	0.50	.48 – .52	200	194 – 206
1M	0.50	.48 – .52	200	194 – 206
2M	0.50	.45 – .55	200	184 – 216
1K	0.30	.28 – .32 (REF)	100	94 – 106 (REF)
10	0.30	.28 – .32	100	94 – 106
50	0.30	.28 – .32	100	94 – 106
100	0.30	.28 – .32	100	94 – 106
1M	0.30	.28 – .32	100	94 – 106
2M	0.30	.35 – .45	100	84 – 116

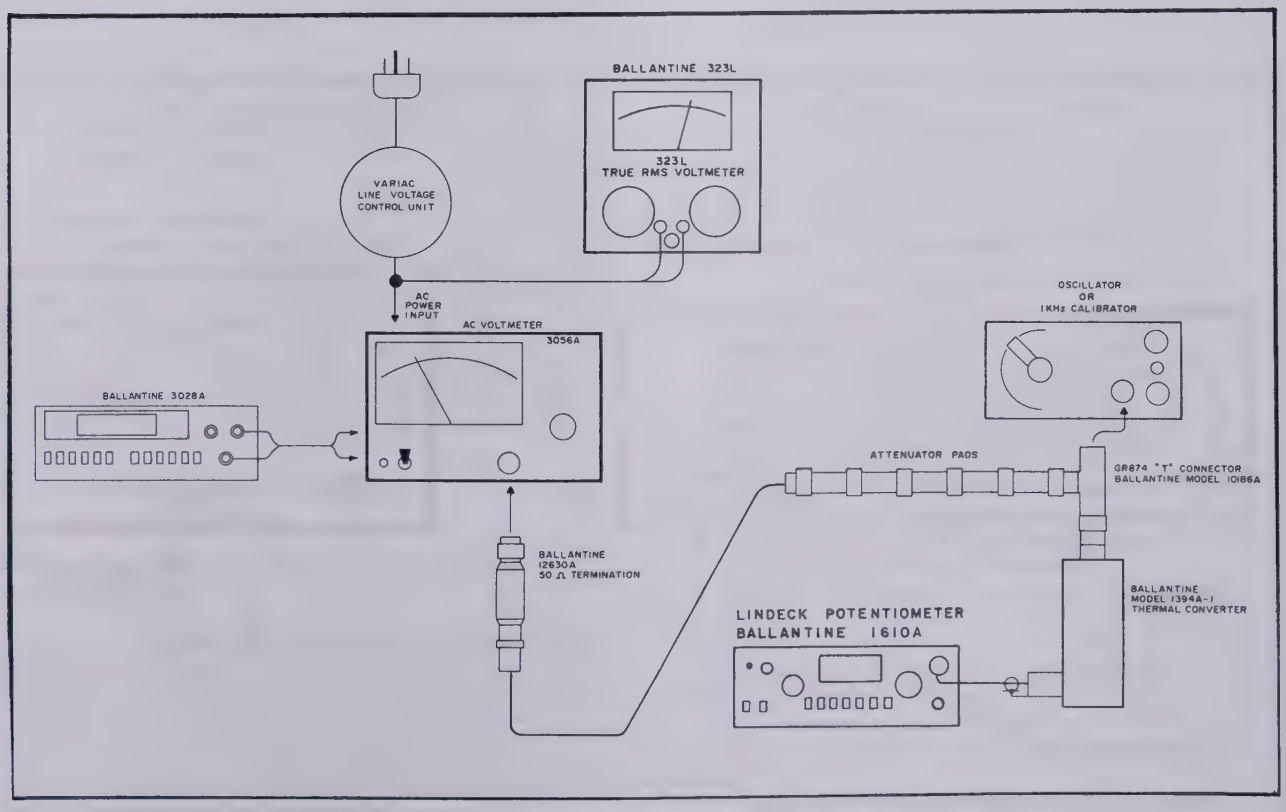


Figure 5-3 Frequency Response Test Setup

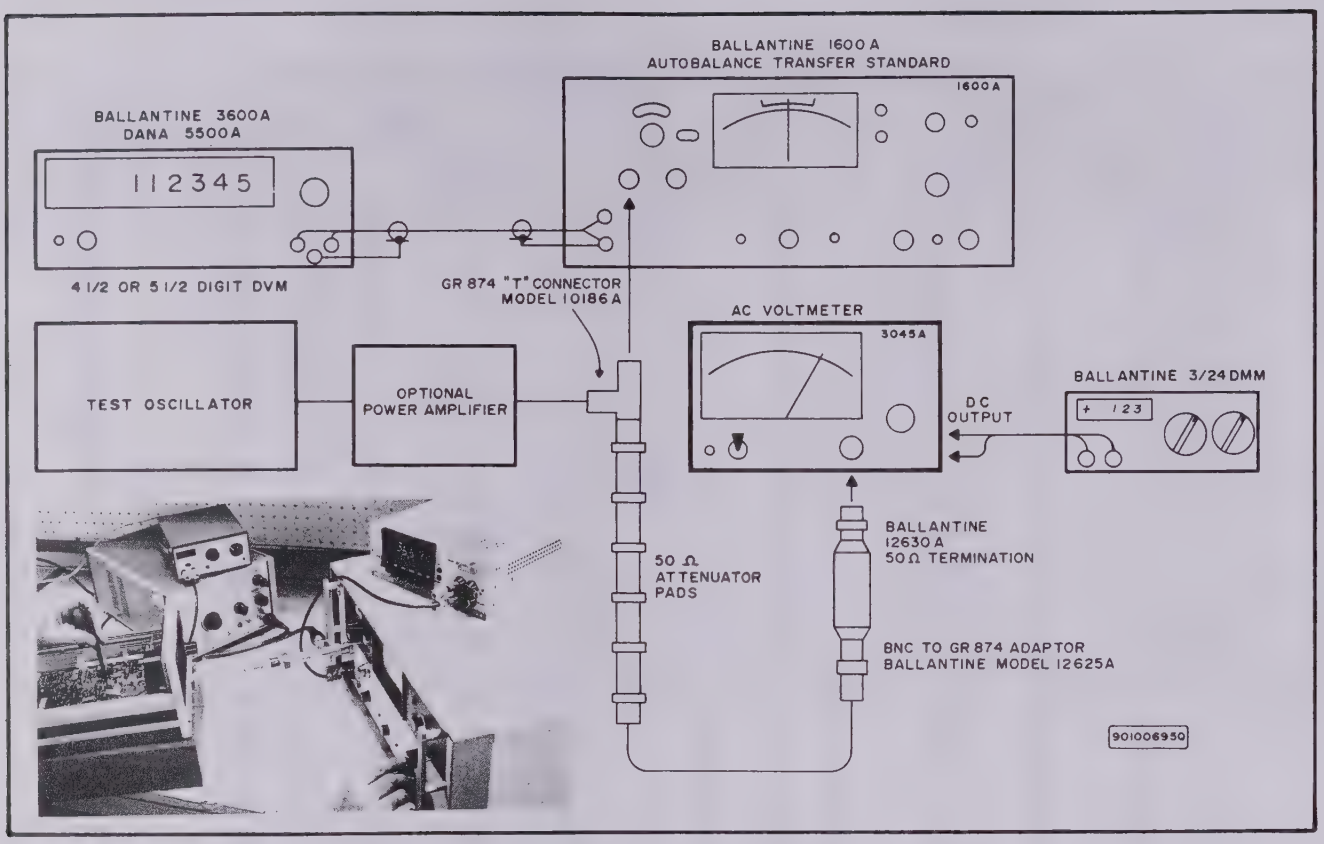


Figure 5-4 Autobalance Transfer Standard Test Setup

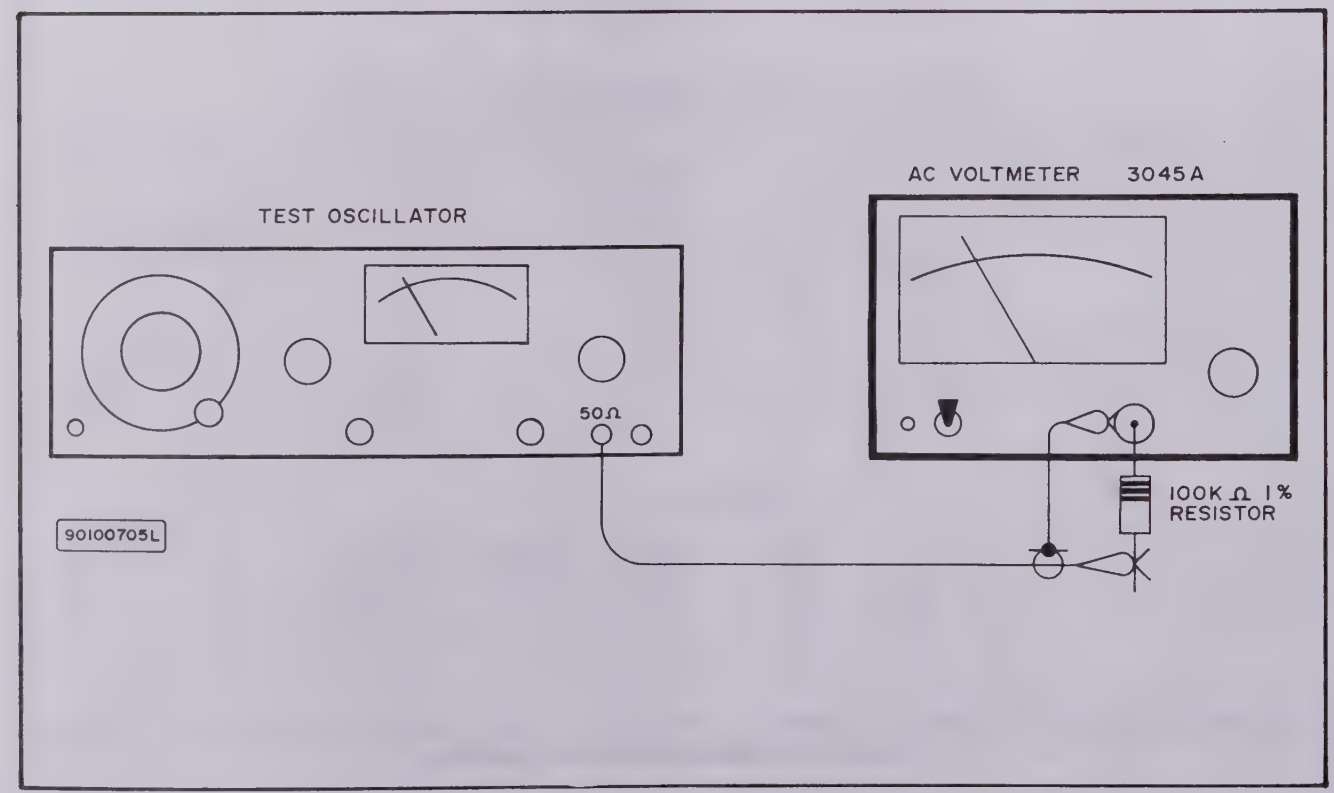


Figure 5-5 Input Impedance Test Setup

5-50. Vary the power line voltage to the voltmeter from 115 (230) volts to 90 (180) volts and note that the voltmeter reading changes less than half percent.

5-51. Vary power line from 115 (230) volts to 135 (270) volts and note that the voltmeter readings change less than half percent.

5-52. CONCLUSION OF PERFORMANCE CHECKS.

5-53. When the 3045A series voltmeter has passed the above "covers on" Performance Assurance Checks, it has met its specifications as listed in Table 1-1. A calibration certification record may be maintained using Form 5-1.

5-54. CALIBRATION AND ALIGNMENT PROCEDURE

5-55. The alignment and calibration procedures are "covers off" procedures to adjust the 3045A series of voltmeters to their performance specifications. If the voltmeter cannot be properly adjusted refer to the troubleshooting and fault finding procedures in paragraph 5-83.

5-56. REMOVAL OF COVERS

The top and bottom covers of the 3045A series voltmeters are each retained by four half turn plastic fasteners. To remove the covers simply give each fastener a half turn to disengage the fastener pawl from under the end frame castings. Hold the cover firmly with both hands but do not press inward. Then simply lift the covers up and away from the instrument. To replace covers reverse the above procedure. Be sure that the covers slide into the retaining slot provided in the side extrusions and make certain all four fastener pawls engage the respective end castings. Turn the fasteners with care to avoid breakage.

—NOTE—

When making final calibration adjustments always have the bottom cover firmly installed since it serves as a shield to minimize noise pick up.

5-57. Preliminary Inspection

5-58. Always check the voltmeter for mechanical damage, loose parts, faulty solder joints, burned resistors, etc. Use a low wattage (25 watt) grounded soldering iron to make repairs and always replace components with exact equivalents to be certain that all performance specifications can be obtained. Use heat shunts when soldering diodes and semiconductors. Do not overheat circuit board printed wiring and pads.

5-59. INTERNAL ADJUSTMENTS AND TEST POINTS

5-60. See Figure 5-6 for the location of internal adjustments and test points.

5-61. The adjustments for **X1** Gain (**A1R241**), **X0.1** Gain (**A1R239**), Meter **X1** Linearity Adj. (**A1R243**), Meter **X0.1** Linearity Adj. (**A1R257**), and DC Out Gain Adj. (**A1R247**) are accessible from the rear panel in some instruments while others provide only access with covers off. (i.e. 3015A **MOD-91**). The maintenance engineer may change to potentiometers which mount flat on the printed circuit board if only "covers off" access is desired. See attached parts list for identification of Ballantine parts for further details.

5-62. INITIAL POWER SUPPLY CHECK

a. Connect the AC power line input to the voltmeter thru a line voltage control unit (Variac) and provide a true rms voltmeter to measure the input line voltage to the instrument under test.

b. Connect digital multimeter test leads to TP-L and the DC output circuit ground binding post J9 on the rear of the instrument. In voltmeters which do not incorporate a DC output, simply use any convenient case or circuit ground. Set the **DMM** to the 100 volt dc range.

c. Vary the input ac power line voltage from 90 to 135 volts (180 to 270 volts) and note that the +12 volt bus reads in the range of +11.3 to +12.7 volts with less than ± 0.2 volts change due to line voltage variation. .2MV RMS RIPPLE

d. Move the **DMM** test probe from TP-L to TP-N and repeat Step c. Check that the -12 Volt bus reads in the range of -11.3 to -12.7 Volts with less than ± 0.2 Volts change due to line voltage variation.

e. Return Variac to midline 115V (230V) and disconnect the **DMM** test leads.

5-63. **Initial Control Settings**
Applicable to all adjustments unless otherwise indicated.

a. Front Panel

RANGE	30 mV
RANGE MULTIPLIER	X1
FILTER	100 kHz
ON/OFF POWER	OFF
FLOAT	⏚
REL REF (3046A only)	CAL

b. Rear Panel

115/230 Volts	As required
BAT CHARGE (option MOD-05)	NORM

5-64. BIAS ADJUSTMENTS

5-65. **Input Amplifier DC Adjustments (A1R109)**

— NOTE —

Make checks with a battery-powered **DMM** which permits floating off-ground measurements. Connect the **DMM LO** input to the voltmeter circuit ground at **J9** on the rear panel. In voltmeters which do not incorporate **J9**, simply use a convenient circuit ground point. **ALWAYS** use a 10 kΩ decoupling resistor at the **DMM HI** input test probe tip. This must be done when performing dc bias adjustments or whenever checking dc voltages in the voltmeter circuitry.

a. Connect a 50 Ω **BNC** termination (Ballantine 12530A) to input **BNC** to "short input."

b. Set **DMM** to the 1000 mV DC range.

c. Connect **DMM** leads from **TP-B** at **A1Q101** to **TP-E** at **A1Q105**.

d. Adjust **A1R109** to have **DMM** read "0" (±10 mV).

e. Disconnect **DMM** probes.

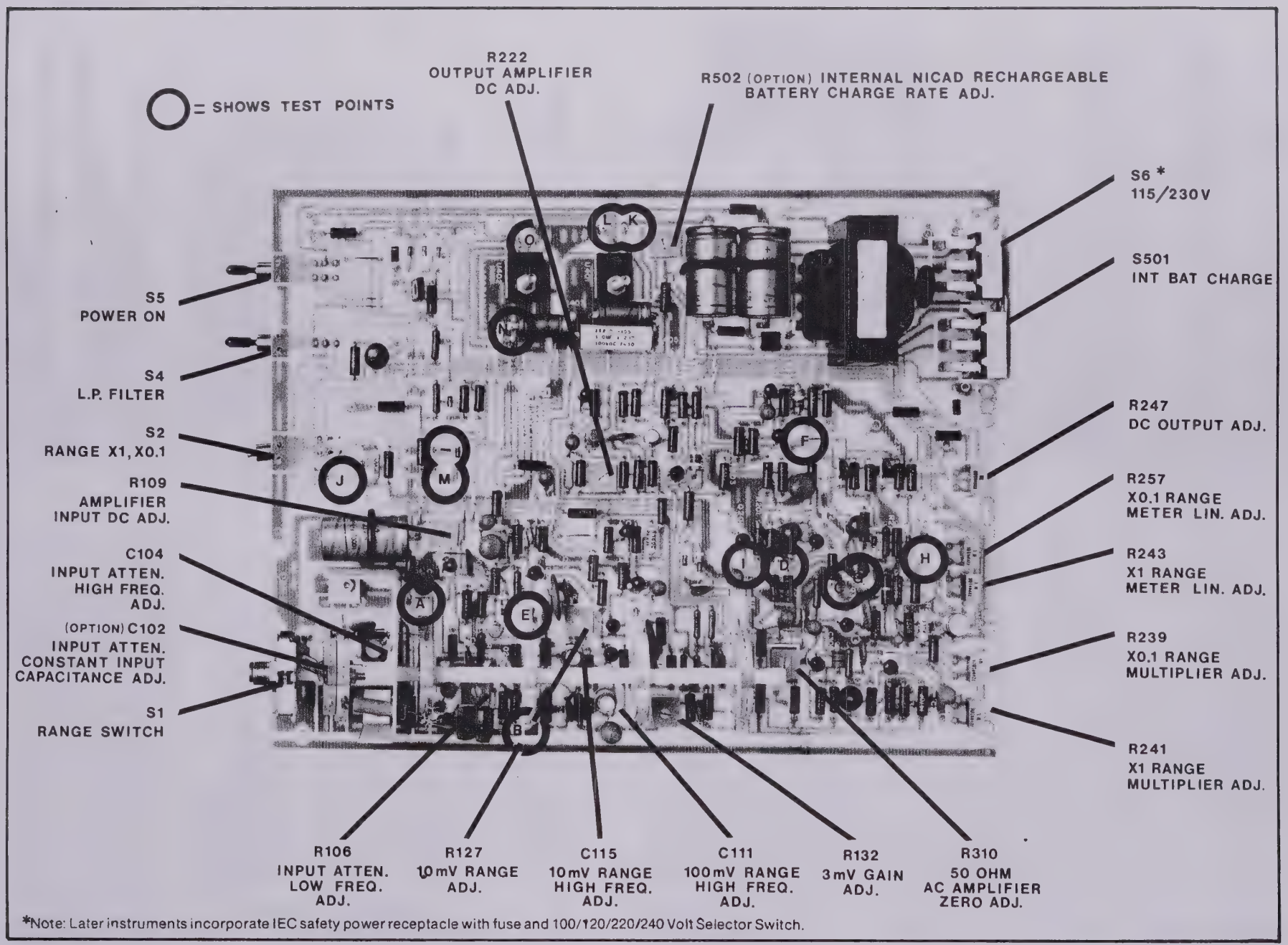


Figure 5-6. Location of Adjustments and Test Points

5-66. **Output Amplifier DC Adjustments (A1R222)**

a. Connect **DMM** probe to the emitter lead of **A1Q206** at **TP-F** and other probe to circuit ground at **J9** on the rear panel.

b. Adjust **A1R222** to have **DMM** read zero mV (±30 mV).

c. Disconnect **DMM** probe from **TP-f**.

5-67. **50 Ω AC Output Zero Adj.(A1R310)**

5-68. Connect **DMM** test lead to 50 Ω output **BNC** (**J2**) and circuit ground. Set **DMM** to 1000 mV dc Range. Adjust **A1R310** to zero the 50 Ω output dc level (±50 mV). Disconnect the **DMM** test leads and the 50 Ω termination at the input **BNC** (**J1**) connector.

5-69. CALIBRATION

5-70. **Preliminary Meter Linearity Adjustments (A1R243)**

a. Connect AC calibrator to input **BNC** (**J1**) of voltmeter under test. See Figure 5-1.

b. Set 3045A series voltmeter to 100 mV range and apply 30 mV rms of 1kHz from the calibrator.

c. Adjust A1R243 to have meter read 0.3mV on the 1 Volt scale (**X1**).

—NOTE—

All the following adjustments must be made in the sequence given below.

5-71. **3 mV Gain Adjustment (A1R132)**

a. Connect the AC calibrator (Ballantine 421A) to the input **BNC J1** of the 3045A series voltmeter. Connect a DC digital voltmeter to the DC output. See Figure 5-1.

—NOTE—

Instruments that do not have a DC output (3015) will use the 0 to 1 scale for calibration. Read the dc DVM as 1000mV equals full scale meter deflection.

b. Set calibrator to:
1 kHz rms
1 mV range
1.000 setting (for 1mV output)

c. Set the 3045A series voltmeter **RANGE** to 1 mV.

d. Temporarily adjust **A1R127**(the 10 mV gain adjust) and **A1R241** (the X1 gain adjust) until the meter reads full scale. Also adjust the DC output adjustment (**A1R247**) until the digital meter reads 1000 mV. Final settings of all three of these adjustments will be made later.

e. Switch voltmeter **RANGE** to 3 mV.

f. Increase calibrator output to 3.16 mV.

g. Adjust **A1R132** for full scale meter deflection (1.0) which should also provide 1000 mV on the digital DC meter. This adjustment normalizes the mid-range attenuator to the output impedance of the input amplifier.

5-72. **X0.1 Range MULTIPLIER Calibration (A1R239 and A1R257).**

a. Set 3045A series voltmeter **RANGE** switch to 100 mV.

b. Set range **MULTIPLIER** to **X0.1**.

c. Connect the AC amplitude calibrator to the voltmeter input **BNC** connector (**J1**). See Figure 5-1. Apply 9.000 mV of 1 kHz rms calibration signal to the voltmeter.

d. On the 3046A be sure the **REL. REF.** control is set to **CAL**.

e. Adjust **A1R239** to give a meter reading of precisely 0.9 of full scale. If 0.9 meter indication cannot be obtained by adjusting **A1R239**, set **A1R239** to approximately twenty degrees back from the end of potentiometer rotation which gives the closest meter reading to 0.9. Reduce calibration signal to 3.000 mV. Adjust **X0.1** meter linearity adjust **A1R257** for a meter reading of 0.3. Then repeat the 0.9 meter indication by again setting the calibrator to 9.000 mV and adjusting **A1R239**. If necessary repeat this procedure to optimize calibration and linearity.

5-73. **DC Output Calibration [A1R247]**

a. Set 3045A voltmeter controls

LP FILTER	100 kHz
RANGE	100 mV
Range MULTIPLIER	X0.1
REL. REF. (3046A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 9.000 mV of 1 kHz rms signal.

c. Connect a digital multimeter to DC output binding posts **J9** and **J10**. See Figure 5-1. Set **DMM** to 1000 mV DC range.

d. Adjust **A1R247** to give a **DMM** reading of 900 mV (±3 mV).

e. Optional - Recheck **X0.1** Meter Linearity control (**A1R257**). Reduce calibrator to 3.000 mV and check that the **DMM** reads 300 mV (± 5 mV). If necessary repeat paragraph 5-72, Step "e" using the **DMM** as an indicator for adjustment.

5-74. **X1 Range Multiplier Calibration (A1R241 and A1R243).**

a. Set 3045A series voltmeter controls

RANGE	100 mV
L.P. FILTER	100 kHz
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect AC Voltage Calibrator to the input of the voltmeter and apply 90.00 mV of 1 kHz rms.

c. Adjust the **A1R241** to give a meter reading of 0.9 of full scale. Note that the **DMM** connected to the DC output binding posts reads 898 to 903 mV.

d. Reduce claibration voltage to 30.00 mV and adjust **X1** meter linearity. Adjust **A1R243** for a meter reading of 0.3. Then repeat the 0.9 meter indication by again setting the calibrator to 90 mV and adjusting **A1R241**. If necessary repeat this procedure to optimize calibration and down scale linearity.

d. Optional - Check linearity and cardinal point alignment.

Calibrator	Cardinal Point	DMM Reading	Meter Reading
100.00	10	995 to 1005	9.9 to 10.1
90.00	9	898 to 903	8.95 to 9.05
80.00	8	795 to 805	7.9 to 8.1
70.00	7	695 to 705	6.9 to 7.1
60.00	6	595 to 605	5.9 to 6.1
50.00	5	495 to 505	4.9 to 5.1
40.00	4	395 to 405	3.9 to 4.1
30.00	3	192 to 207	2.9 to 3.1
20.00	2	192 to 207	1.9 to 2.1
	(3045A only)		
10.00	1	090 to 110	0.8 to 1.2
	(3045A only)		

If necessary, repeat paragraph 5-74.

5-75. **10 mV Range Calibration (A1R127)**

a. Set 3045A series voltmeter controls

RANGE	10 mV
L.P. FILTER	100 kHz
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 9.000 mV 1 kHz rms.

c. Adjust **A1R127** to have meter read precisely 0.9 full scale. Note that the **DMM** connected to the DC output binding posts reads 900 mV (±2 mV.)

5-76. **Input Attenuator Low Frequency Calibration (A1R106)**

a. Set 3045A series voltmeter controls

RANGE	1 Volt
Range MULTIPLIER	X1
L.P. FILTER	100 kHz
REL. REF. (3046A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 0.9000 Volts 1 kHz rms.

c. Connect a digital multimeter to the DC output binding posts. Set the **DMM** to 1000 mV DC.

d. Adjust **A1R106** to obtain a **DMM** reading of 900 mV (±2 mV) and note a meter reading of 0.9 of full scale.

e. Optional - Attenuator Decading Checks

AC Calibrator	Voltmeter Range	Touch Up Adj.	DMM	Meter
90.00 mV	100 mV	R241-METER R247-DMM	893 to 905	.89 to .91
.9000 mV	1 mV	R127	893 to 905	.89 to .91
9.000 mV	10 mV	R132	893 to 905	.89 to .91
.9000 mV	1 V	R106	893 to 905	.89 to .91
9.000 V	10 V	-	893 to 905	.89 to .91
90.00 V	100 V	-	893 to 905	.89 to .91

5-77. **100 mV Range High Frequency Calibration (A1C111)**

a. Set 3045A series voltmeter controls

RANGE	100 mV
L.P. FILTER	OUT
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect a digital multimeter to the DC output binding posts. Set the **DMM** range to 1000 mV DC.

c. Connect constant amplitude signal generator (**CASG**) Tek 191 with 20 dB **GR874** attenuator pads and 50Ω feed thru termination to voltmeter input **BNC (J1)**. Monitor **CASG** output of **CASG** with Ballantine 1394-1 thermal converter and monitor its thermo-element output with a 10 μV resolution DC digital voltmeter (or H-P 3420B Delta-Volter). See Figure 5-3.

d. Set **CASG** to 50 kHz and increase its output signal amplitude until the **DMM** reads 1000 mV. Note the output voltage from the thermo-element.

e. Increase the frequency of the **CASG** to 5 MHz and adjust the **CASG** output amplitude to maintain the thermo-element output voltage noted in Step "d"

f. Adjust **A1C111** until the DC output voltage read on the **DMM** falls within the limits of the following tabulation. If necessary adjust **A1C111** to fit all frequency response points.

Frequency	Meter	DMM Reading		
	3015A	3045A/3046A	3015A MOD 91	3015A MOD 92
50 kHz		1000 mV	1000 mV	1000 mV
1MHz	.970 to 1.030	990 to 1010	990 to 1010	990 to 1010
2.5MHz	.945 to 1.055	988 to 1012	970 to 1030	980 to 1020
5 MHz	.940 to 1.060	950 to 1040	950 to 1050	970 to 1030
10 MHz	N/A	950 to 1050	950 to 1050	N/A
15 MHz	N/A	910 to 1090	N/A	N/A

5-78. **10 mV Range High Frequency Calibration (A1C115)**

a. Set 3045A series voltmeter controls

RANGE	10 mV
L.P. FILTER	OUT
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect a digital multimeter to the DC output binding posts. Set the **DMM** range to 1000 mV DC.

c. Connect constant amplitude signal generator (**CASG**) Tek 191 with 20 dB **GR874** attenuator pads and 50Ω feed thru termination to voltmeter input **BNC (J1)**. Monitor **CASG** output of **CASG** with Ballantine 1394A-1 thermal converter and monitor its thermo-element output with a 1 μV resolution DC digital voltmeter (Ballantine 3620A or H-P 3420B Delta-Volter). See Figure 5-3.

d. Set **CASG** to 50 kHz and increase its output signal amplitude until the **DMM** reads 1000 mV. Note the output voltage from the thermo-element.

e. Increase the frequency of the **CASG** to 5 MHz and adjust the **CASG** output amplitude to maintain the thermo-element output voltage noted in Step "d".

f. Adjust **A1C115** until the DC output provides a **DMM** reading of nominally 1005 mV (999 to 1012 mV).

g. Check the adjustment and fit of all points by repeating the procedure of paragraph 5-77f and adjust **A1C115** if required.

5-79. **Input Attenuator High Frequency Calibration (A1C104)**

a. Set 3045A series voltmeter controls

RANGE	1V
L.P. FILTER	OUT
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect a digital multimeter (Balantine 3/24) to the DC output binding posts **J9** and **J10**. Set **DMM** to the 1000 mV DC range.

c. Connect the high frequency test set up of Figure 5-3. Use the 50 Ω output of the test oscillator (H-P 651) and use the thermal converter monitor as well as a 50 Ω feed thru termination at the input **BNC** of the 3045A series voltmeter.

d. Set the test oscillator frequency to 400 Hz and its output amplitude to give a reading of 1000 mV on the **DMM**.

e. Null the output voltage of the thermal converter on the H-P 3420B Delta-Volter or note the thermal converter on output voltage if a **DVM** is used as monitor.

f. Increase the frequency of the test oscillator to 100 kHz and adjust its amplitude until the same thermal converter null of DVM reading noted in Step "e" is obtained. This assures constant signal input amplitude at 400 Hz and 100 kHz.

g. Adjust **A1C104** until the DC output voltage of the voltmeter measured by the **DMM** is 1000 mV.

5-80. CALIBRATION OF OPTIONAL MODIFICATIONS

5-81. **MOD-10; Input Attenuator Constant Input Capacitance Adjust (A1C102)**

—NOTE—

This adjustment is only required when constant input capacity Option **MOD-10** is installed. Be sure rear input Option **MOD-04** is disconnected at input **BNC (J1)** when adjustment of **A1C102** is made.

a. Set 3045A series voltmeter controls

RANGE	100 mV
L.P. FILTER	OUT
Range MULTIPLIER	X1
REL. REF. (3046A only)	CAL.

b. Connect a 50 Ω precision 20 dB attenuator pad with 50 Ω feed thru-termination to a test oscillator. Connect the termination of the 3045A series voltmeter input **BNC (J1)** thru a 100 k Ω film resistor inserted directly into the **BNC**. See Figure 5-5. Connect the ground lead from the oscillator directly to the voltmeter **BNC** shell.

c. Connect a digital multimeter to the DC output binding posts **J9** and **J10**. Set **DMM** to the 1000 mV DC range.

d. Set the test oscillator to 350 kHz and adjust its output amplitude until the **DMM** reads 1000 mV.

e. Set the 3045A series voltmeter to the 1 Volt **RANGE** and remove the 20 dB attenuator pad to increase the signal amplitude by a factor of ten.

f. Adjust **A1C102** until the **DMM** reads 1000 mV (± 60 mV). **A1C102** is a short length of 75 Ω twin lead cable. Its length determines the capacity shunted across the input on the 1 Volt thru 300 Volt attenuator ranges to make them equal to the 1 mV thru 300 mV ranges. The capacity is adjusted by cutting the exposed end of the twin lead diagonally. **DO NOT** adjust **A1C102** unless the **DMM** reading is out of the ± 60 mV tolerance band. If the reading is more than 1060 mV, replace the 75 Ω twin lead with a new and longer piece. If the **DMM** reading is less than 940 mV trim a small piece of the exposed end of the 75 Ω twin lead by cutting diagonally. Carefully dress the twin lead before making a final trim to bring the **DMM** reading within the range of 940 to 1060 mV.

5-82. **MOD-05; Internal NiCad Rechargeable Battery Option Charge Rate Adjust (A1R502)**

—NOTE—

Be sure that the internal battery and charger components (Series 500) are installed and that **A1R403** is not installed.

a. Be sure the battery is in serviceable condition with no open or shorted cells. If necessary, use a new battery to properly make this adjustment.

b. Open up the positive terminal lead to the battery. Use a soldering iron to unsolder the lead at the battery connector tab.

c. Insert a **DMM** with 100 mA DC ammeter capability (Ballantine 3/24) between the open battery connector tab and the lead disconnected in Step "b"

d. Connect the 3045A series voltmeter to the AC power line and set the **BATTERY CHARGE** slide switch accessible at the rear panel to **FAST**.

e. Adjust **A1R502** until the **DMM** DC ammeter reads 60 (± 5) mA.

f. Switch **BATTERY CHARGE** switch to **NORM** and observe that the ammeter reads in the range of 4 to 12 mA.

g. Remove the AC power cord. Disconnect the **DMM** and reconnect the positive battery lead disconnected in Step "b"

—NOTE—

The battery should be recharged at the **FAST** rate for 10 to 16 hours. The battery voltage on a fully charged battery in good condition will be 28 to 33 Volts DC when powering the 3045A series voltmeter.

5-83. TROUBLESHOOTING AND FAULT FINDING

5-84. The troubleshooting procedures should only be performed when the 3045A series voltmeter cannot be calibrated with the procedure of paragraph 5-66 through 5-82. Should the voltmeter be inoperative or completely out of specifications follow the fault finding procedures listed below.

a. Carefully examine the instrument and check for any visual evidence of trouble. Check for broken wires, burned resistors, loose components, shorts or open or defective solder joints on the printed circuit board. Check for separation of printed circuit board lands and pads. Check for open, defective or intermittent switches. Check that connectors are clean and will mate properly. Check that instrument circuit ground is not shorted to chassis ground in those instruments which incorporate a **FLOAT** mode.

b. Understand and be familiar with the circuit theory of Section 4. Use the functional block diagram of Figure 4-1 and the schematic diagrams Figure 6-1 thru 6-6 to isolate the probable circuit areas which may cause the problem. Always check the power supply voltages and check for oscillations in the circuitry. Then refer to the fault finding and troubleshooting hints for that circuit detailed below. Table 5-10 gives some probable corrections for specific symptoms.

—NOTE—

Test voltages are given below and are also indicated on the schematic diagrams. All measurements are made with a high impedance battery operated floating digital multimeter (Ballantine 3028B). The **DMM** leads should be DC coupled with 10 k Ω resistors at the probe tips to avoid oscillations and input/output coupling in the amplifiers of the 3045A series voltmeter. All voltages are DC and referenced to circuit ground with tolerances ± 20% unless otherwise indicated. The voltmeter should have its input **BNC (J1)** shorted, **RANGE** set to 300 mV, and the **FLOAT** switch set to "⏚".

5-85. POWER SUPPLY

5-86. Use a DC voltmeter (Ballantine 3028B DMM) to check the +12 and -12 Volt supplies. Check the voltages listed on the power supply schematic Figure 6-3 and on Table 5-5. If the measured voltage is incorrect for a given test point or component, the fault is probably in that component or its surrounding circuitry. Use AC power input set to 115 (230) Volts.

TABLE 5-5 POWER SUPPLY VOLTAGES

Component	Test Point	DC Voltage
U401	K to N	+ 32 to + 40 V
U401	L to J9	**+ 11.3 to + 12.7 V**
U402	N to J9	-11.3 to -12.7 V
With MOD-05:		
B501	B + to B-	26 to 33 V
Q501 - Base	to N	1.8 V
Q501 - Emitter	to N	1.2 V
With 3015A-MOD 95		
B502/503	B+ to B–	24 to 32 V Batt. Op. 30 to 36V Charging— Power OFF

5-87. INPUT AMPLIFIER

5-88. With input shorted and **RANGE** switch set to 300 mV check DC voltages with a sensitive DC voltmeter (Ballantine 3028B DMM. Use circuit ground as the reference and connect at binding post **J9** on the rear panel. If voltages are not as indicated, trouble shoot the amplifier and correct the fault before proceding.

TABLE 5-6 INPUT AMPLIFIER VOLTAGES

Transistor	Test Point	Base	Emitter	Collector
Q101	"A" + 2.7	-	-	-
Q101	"B" 0.55±0.25	-	-	-
Q102	-	+ 6.7	+ 7.3	+ 10.3.
Q103	-	+ 7.3	+ 6.7	- 0.3±0.3
Q104	-	+ 7.3	+ 6.7	+ 3.2
Q105	"E" 0.55±0.25	+ 0.55±0.25	-0.3±0.3	- 8.5

5-89. Set 3045A series voltmeter to 300 mV **RANGE (X1)** and apply a full scale 1 kHz signal from AC voltage calibrator (Ballantine 421A). Use 3028B DMM on 1000 mV AC range to check AC signal at TP "I", the output of the input amplifier with maximum post attenuator attenuation. The rms voltage read by the **DMM** should be nominally 33 mV. If this voltage measures correctly the input amplifier operates correctly. If not check the components in the amplifier, leakage in the coupling capacitors, switch continuity and post attenuator operation.

5-90. Switch **RANGE** to 30 mV **(X1)** and adjust the 1 kHz input for a full scale meter reading. Repeat the measurements at TP "I" indicated in paragraph 5-89 to check the high gain operating mode of the input amplifier. Measure 33 mV AC or apply the corrective measures indicated above.

5-91. OUTPUT AMPLIFIER AND METER BRIDGE

5-92. With input shorted and **RANGE** switch set to 300 mV check DC voltages with a sensitive DC voltmeter. Use circuit ground as reference. The DC checks are the best check for the amplifier since it is fully DC coupled and if voltages are incorrect the amplifier will not operate properly.

TABLE 5-7 OUTPUT AMPLIFIER VOLTAGES

Transistor	Test Point	Emitter	Base	Collector
Q201	"I" 0	-0.6	0	- 6.9±1.2
Q202	"C" 2.8±1.5	-0.6	0	2.8±1.5
Q203	–	-6.3±1.2	-6.9±1.2	-10.3 ± 1
Q204	–	-7.0±1.2	-6.3±1.2	-0.6
Q205	–	-7.0±1.2	-6.3±1.2	11±1.6
Q206	"F" 0	0	-0.6	-10.5

5-93. With 3045A series voltmeter range set to 300 mV **(X1)** apply a 1 kHz input signal from an AC voltage calibrator (Ballantine 421A). Adjust the input signal amplitude for full scale meter deflection. Check the DC voltage at TP "G" for a reading of ≈-280 mV and TP "H" for a reading of ≈+ 280 mV. If these voltages are obtained the amplifiers and the average responding meter bridge are operating properly. If not check the circuit components, check capacitors for excess leakage and recheck the DC voltages outlined in Table 5-7.

5-94. METER AMPLIFIER

5-95. The meter amplifier is a DC operational amplifier using negative feedback for gain stabilization. It is, therefore, only necessary to make DC voltage checks on U201. Set **RANGE** to 300 mV, **FILTER** to 100 kHz to reduce noise and make measurements with a high impedance DC voltmeter (Ballantine 3/24 DMM). The meter should read zero with no input signal.

If any of these voltages cannot be obtained check the components, switch **S2B** or replace **U201**. Note that the output of **U201** with full scale meter deflection is +2V (±0.2V) measured at TP "J"

TABLE 5-8 METER AMPLIFIER VOLTAGES

	Pin 2	Pin 3	Pin 4	Pin 6	Pin 7
U201	0±0.2V	0±0.2V	-12V	+0.6±.3V	+12V
CR801	0.6V±0.3V		across diode		
CR802	0.6V±0.3V		across diode		

5-96. AC OUTPUT AMPLIFIER

5-97. To check the AC Output Amplifier for faults, first check the schematic diagram of Figure 6-2 or 6-5 applicable to the instrument under test. Then measure the DC voltages given in Table 5-9. Any incorrect voltage will indicate trouble in the associated stage.

TABLE 5-9 AC OUTPUT AMPLIFIER VOLTAGES

	EMITTER	BASE	COLLECTOR
Q301	-5.6	-6.2	-10.0±1
Q302	-1.7	-2.4	-6.2
Q302 (3015A only)	-2.3	-2.9	-5.1
Q303	-2.2	-2.8±1.5	-11.0

5-98. PRINTED WIRING BOARD REPAIR AND CLEANING

5-99. The Ballantine 3045A series voltmeters use an etched copper printed circuit board. The main printed circuit board has conductors only on one side and does not use plated thru holes. To prevent damage to the circuit board and components observe the following instructions when soldering:

a. Use a low-heat capacity (Weller Model No. W-TCP 60 watt) soldering iron with a 700°F tip 1.5mm (1/16") to 2.5mm (3/32") wide.

b. Be sure that the soldering iron tip is grounded to the power line "earth" ground to avoid possible overvoltage damage to semiconductors and tantalytic capacitors. Also "earth" ground the case of the voltmeter.

c. To remove a component, clip a heat sink such as long nose pliers, tweezers or alligator clips onto the component lead and as close to the body of the component as possible. This assures minimum heating of the component while soldering.

Place the soldering iron directly on the component lead on the printed circuit conductor side of the board. Use a desoldering tool such as the SOLDAPULLT (manufactured by EDSYN Products) to remove all solder and free the component lead.

Straighten the bent over component lead with long nose pliers.

Pull the component out of the hole.

If a component is obviously faulty or damaged simply clip the leads close to the body of the component and remove the remaining leads thru the conductor side of the circuit board.

CAUTION

Always use a short soldering cycle since excessive or prolonged heat may destroy the laminate bond and lift the copper conductors from the circuit board or cause immediate degradation or latent damage to the components.

d. Always clean the component lead holes by heating the solder on the circuit board conductor pad, then quickly remove the soldering iron and insert a pointed non-metallic object such as a toothpick to clean the hole. Never let solder cover the hole, since the incoming new component lead may then push the pad from the circuit board.

e. To install a new component, straighten and shape the leads. Insert the component into the proper holes. Bend the leads at the conductor side of the circuit board so they fall over the pad and extend over the foil of the incoming conductor path. Cut the bent lead approximately 2.5 mm (3/32") from the hole.

Clip a heat sink to the component lead at the body of the component. Heat the lead and pad with a soldering iron and use fresh solder (60-40) as required to cover the lead and form a meniscus over the hole to assure a good electrical connection.

f. Clean excess flux from the connection and surrounding area. Use TF Freon spray cleaner (such as Miller Stevenson Chemical Co., Type MS-180, Ballantine P/N 80-10004-0A) and use light air pressure (5 to 20 PSIG) and a clean soft brush to clean board and components. Use a humidity seal spray (such as Humiseal, Columbia Technical Corp., Type 1B15. Ballantine P/N 80-10005-0A) to seal board and protect against humidity.

— NOTE —

Do not touch cleaned board or excessively handle components to avoid unwanted leakage which may affect performance when exposed to high humidity.

TABLE 5-10 TROUBLESHOOTING AIDS

SYMPTOM	PROBABLE FAULT
1. Front Panel Pilot Lamp does not illuminate when power switch is **ON**.	1. AC power cord not properly inserted. Check power line fuse **F1**. If battery operated recheck battery. Check polarity of external battery connected to **J7** and **J6** (+). Check condition of **U401** and **U402**. Check + 12V and -12V power supplies.
2. Meter reads up scale with no signal input.	2. Short input **BNC** connector **J1**. Set **FLOAT** switch to 1 Check for large external fields or improper power line voltages. Check adjustment of Meter Linearity and Zero Control **A1R243**. Turn instrument power **OFF** and check mechanical meter zero adjust. Check DC output reading and check or change meter if meter does not respond proportionally to DC output voltage. Check for oscillations by changing **RANGE**. Check high frequency calibration of **A1C111** and **A1C115**.
3. No meter response to input signal.	3. Check input fuse **A1F2** if one is installed in the instrument. Check power supply voltages. Check dc and ac signal operation detailed in Paragraphs 5-87 through 5-95.
4. High + 12 Volt and -12 Volt Supply.	4. Check for incorrect setting of 115/230 Volt switch. Check **A1U401** and **A1U402** for shorted integrated circuit. Check **A1U402** for open or non-regulating circuit. Replace regulators with units that are within rated voltage.
5. Low + 12 Volt and -12 Volt.	5. Check setting of 115/230 Volt switch. Check line voltage input. Check for leaky or defective filter capacitors **A1C401** and **A1C402**. Check operation of rectifier bridge. See that oscilloscope at test point shows ripple wave shape or replace rectifier and/or filter's capacitors. Replace regulators with units that are within rated voltage. Check that input current to **A1U402** does not exceed 100 mA. Check possible defect in AC rectifiers and transformer by disconnecting AC power and using an external battery or DC power supply. In DC powered operation note that diodes **A1CR505** and **A1CR506** have a voltage drop less than 1 Volt.
6. Meter Oscillates or "swings".	6 Check power supply regulators if meter "swings" or beats when an input signal is applied which is close to the frequency of the power line or its harmonics.
7 .Large Oscillations and instability in meter and AC Output	7. Check power supply. Short input. Recalibrate **A1C111** and **A1C115** according to Paragraphs 5-77 and 5-78. Check for leaky coupling capacitors and incorrect DC voltages in the amplifiers. Ground **TP** at input to output amplifier with short leads to eliminate loop oscillations. Remove instrument away from large AC radiated fields. Set **FLOAT** switch ⏚ If Check that **A1C222** is not open. If using rear input **MOD-04** terminate with 50 Ω on front panel **BNC** and if necessary increase **R107**. See Paragraph 3-13.
8. High or low gain at high frequencies on all ranges.	8. Recalibrate **A1C111** and **A1C115** according to Paragraph 5-77 and 5-78.
9. High or low gain at high or low frequencies only on 1 Volt thru 300 Volt ranges.	9. Recalibrate the input attenuator compensating capacitor **A1C104** according to Paragraph 5-79.
10. Meter responds improperly when AC input signal is superimposed on high DC level.	10. Replace input coupling capacitor **A1C101**.
11. Low gain at high frequencies on all ranges.	11. Check that **L.P. FILTER** switch is set to **OUT**. Recalibrate **A1C111** and **A1C115** according to Paragraphs 5-77 and 5-78.

TABLE 5-10 TROUBLESHOOTING AIDS (continued)

SYMPTOM	PROBABLE FAULT
12. Low gain at high or low frequencies only on 1 Volt thru 300 Volt ranges.	12. Recalibrate the input attenuator compensating capacitor **A1C104** according to Paragraph 5-79.
13. Low gain at low frequencies on all ranges.	13. Check **A1C101**, **A1C134** and **A1C123** and replace as necessary. Check condition of input **FET A1Q101** and replace its leaky or low gain. Check **A1C217** and **A1C218**.
14. Instrument will not range properly on 100 mV and 300 mV ranges and 100 Volt and 300 Volt ranges.	14. Check that deck **E** of **RANGE** switch **A1S1** is shorted in these ranges and that **A1R121** is shorted by deck **E**.
15. Instrument will not range properly on 1 mV thru 30 mV and 1 V thru 30V ranges.	15. Check that deck **E** of **RANGE** switch **A1S1** is open only on these ranges and that **A1R121** is effective.
16. Low readings near full scale on all ranges.	16. Check **A1CR201** and **A1CR202**. Also check **A1U201** and recalibrate **X1** gain **A1R241** and/or **X0.1** gain **A1R239**.
17. Readings low on 300 mV and 300 Volt ranges near full scale.	17. Check input amplifier and **A1Q105**.
18. **RANGE** switch operation is erratic and/or some ranges will not operate.	18. Check switch wafers for continuity. Replace wafers that show noisy or intermittent operation. Check that detent is properly aligned. Check that all switch wafers are properly and squarely soldered into printed circuit board. Check that plastic switch shaft is not warped so that rearmost wafers **DO NOT** align properly and replace shaft if necessary.
19. Instrument will not range properly on 1 mV thru 300 mV ranges or 1 Volt thru 300 Volt ranges.	19. Check **RANGE** switch **A1S1** decks A, B and C. Check **A1R103** for improper low voltage ranging and **A1C104**, **A1R105**, **A1R144/5/6** and **A1C105/41/42** for improper high voltage ranging.
20. Oscillations when using 50Ω or 600Ω AC outputs.	20. Check lead dress of AC output leads to their respective **BNC** connectors. Check ground leads to these connectors and dress AC output leads away from DC output leads. Break ground loop thru power line ground by using 2 to 3 wire adapters on the power cable. Operate from external or internal battery to eliminate ground loop problems. See Section 3.
21. 1 mV range slightly out of calibration.	21. Fully recalibrate instrument and check **A1C134**, **A1C123** as well as **A1R133** and **A1C131**.
22. Excessive noise on 100μV and 300μV ranges.	22. Check power supply. Operate on batteries to check AC effects. Remove instrument and input cabling away from high radiated fields. Check for intermittent switches and connections. Replace input **FET A1Q101**.
23. **AC OUTPUT** Amplifier output signals low.	23. Check **A1Q301**, **A1Q302**, **A1Q303**, **A1C303** and other associated components. Check that the series combination of **A1C309** and **A1R309** is shorted across **A1R105** in the **X0.1** mode.
24. 50Ω **AC OUTPUT** distorted or not zero based.	24. Adjust **A1R310** and check components in the surrounding amplifier circuitry.
25. Poor meter tracking or linearity on **X0.1** Range Multiplier.	25. Readjust **A1R239** for full scale and **A1R257** for 0.3 tracking. Follow the calibration procedure of Paragraph 5-72.
26. Poor meter tracking or linearity on **X1** Multiplier Range.	26. Readjust **A1R241** for full scale and **A1R243** for 0.3 down scale tracking.

NOTES

PERFORMANCE TEST RECORD

Ballantine Model _____ **MOD.** _____ **Serial No.** _____

Test Performed By: _____ **Date:** _____

1. POWER SUPPLY CHECK

	Specification	Indication
Low line	< 90 (180V) rms	
High Line	> 135 (270V) rms	

2. ACCURACY CHECK — Full Scale

	Input		Specification		Indication	
RANGE	Volts	Frequency	Meter (% of Reading)	DC Output (mVolts)	Meter (% of Reading)	DC Output (Volts)
1mV X0.1	1mV	1kHz	1±1%	993 to 1015		
1mV X1	10mV	1kHz	1±1%	995 to 1005		
3mV X1	3mV	1kHz	3±1%	944 to 954		
10mV	10mV	1kHz	1±1%	995 to 1005		
30mV	30mV	1kHz	3±1%	944 to 954		
100mV	100mV	1kHz	1±1%	995 to 1005		
300mV	300mV	1kHz	3±1%	944 to 954		
1V	1.00V	1kHz	1±1%	995 to 1005		
3V	3.00V	1kHz	3±1%	944 to 954		
10V	10.0V	1kHz	1±1%	955 to 1005		
30V	30.0V	1kHz	3±1%	944 to 954		
100V	100V	1kHz	1±1%	995 to 1005		
300V	300V	1kHz	3±1%	944 to 954		

3. FREQUENCY RESPONSE TOLERANCE

For Specifications Use Table 5-4 as applicable.

If desired use the 1 Volt RANGE tolerances for making optional checks of the 1mV, 10mV, 100mV, 10V and 100V RANGES and the 300mV RANGE tolerances for the 3mV, 30mV, 3V, 30V and 300V RANGES.

	Input		Specification		Indication	
RANGE	Volts	Frequency	Meter (% of Reading)	DC Output (Volts)	Meter (% of Reading)	DC Output (Volts)
1V	1.00	1kHz	±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	1.00		±%	1.00 ±0.		
	0.05	1kHz	±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		
	0.50		±%	0.50 ±0.		

cut along dotted line

RANGE	Input		Specification		Indication	
	Volts	Frequency	Meter (% of Reading)	DC Output (Volts)	Meter (% of Reading)	DC Output (Volts)
300mV	0.30	1kHz	±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.30		±%	.949 ±0.		
	0.10	1kHz	±%	.316 ±0.		
	0.10		±%	.316 ±0.		
	0.10		±%	.316 ±0.		
	0.10		±%	.316 ±0.		
	0.10		±%	.316 ±0.		
	0.10		±%	.316 ±0.		
	0.10		±%	.316 ±0.		

4. INPUT IMPEDANCE

	Specification	Indication
RESISTANCE CHECK	10MΩ < 1 minor div.	
CAPACITANCE CHECK		
1mV to 300mV RANGE	< 24pF > 66 kHz	kHz
1V to 300V RANGE	< 22pF > 72 kHz	kHz
with CONSTANT Input Capacity	20 to 24pF > 66 kHz	kHz

5. AC AMPLIFIER OUTPUT

	Specification	Indication
Full Scale Output X1 Multiplier into open circuit	Min mV rms	
50 Ω		
1kHz	≤ 150	mV
10Hz to 1kHz	< 135	mV
1kHz to 4MHz	< 147	mV
4MHz to 10MHz	< 141	mV
600 Ω		
1kHz	≥ 1000	mV
10Hz to 1kHz	> 900	mV
1kHz to 4MHz	> 950	mV
4MHz to 10MHz	> 800	mV

6. AC TO DC CONVERTER OUTPUT RESISTANCE

	Specification	Indication
Output Resistance	450Ω to 550Ω	Ω

Parts List and Circuit Diagrams

The replacement parts listed are available from the vendors listed or from Ballantine Laboratories. Your local Ballantine Field Engineering Representative may also carry a stock of parts and can assist you. If pricing quotations are required for parts and or repairs your local representative will give the most rapid service or you may contact the Ballantine Factory directly.

When ordering replacement parts always give the following information:

a) Instrument Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification and description of the part

Ballantine will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of the components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The instrument may substitute alternate components but the use of parts specified in this parts list is recommended. A part similar to the part initially installed at the factory may be used, i.e., a 5% composition resistor may be replaced with a similar part or a 5% film resistor or the preferred 1% metal film resistor. Use of the preferred component will always simplify calibration and speed repairs.

Any selected component is generally identified in this manual and may be replaced with a similarly valued part unless reselection is required due to replacement or change of its related part. The schematics and calibration procedures identify selected components and replacement procedures.

The Manufacturer Code is taken from Federal Supply Code Cataloging Handbooks H4-1, H4-2, and H4-3. Ballantine Code is 50423.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWC	Switch
LMP	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CCW) type N-55, N-60 and C-32. Allen Bradley carbon composition resistors type EB may also be used but should generally be avoided (except for emergency replacements) in favor of the preferred part listed in this parts list.

Main P.C. Board (3045A and 3046A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 101	07102500A	CYM 68.0NF 630.0 VK MET POL	80031	MEPCO C280MCG/A68K
C 102	79054730A	CBL FXR	29587	AMPHENOL #214-079
C 103	07095740A	CCD 1.5NF 1.0KV +-10%	71590	CTL TYP DD-152
C 104	07101780A	CVP 10.0PF 750.0 VT 2-10PF	50423	JACKSON BROS. 5640/PM
C 105	07102150A	CMM 1.1NF 500. VJ SILV MI	84171	ARCO CM20E112J OR EQUIV.
C 106	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 107	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 108	07078330A	CEA1000 UF 16 V T	73445	AMPEREX C437AR/E1000
C 109	07100060A	CCD 4.7PF 500 V DISC.	90201	RMC TYPE CG
C 110	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 111	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	JACKSON BROS 5750
C 112	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CD00B102F180J
C 113	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 114	07025080A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C 115	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	JACKSON BROS 5750
C 116	07095800A	CDD 100 PF J 5%	56289	SPG TYP 10TCC-T10
C 117	07101530A	CCD 6.8PF 500.0 V NPO+-1PF	72982	ERIE 801 NPO 6.8PF 1P 500V
C 118	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 119	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 120	07102360A	CCD 3. NF 1. KVK	56289	SPRAGUE C016B102K302K
C 121	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 122	07102430A	CCD 6.8NF 250.0 VK	56289	SPRAGUE C067A251J682K
C 123	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 125	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CD00B102F180J
C 126	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 127	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 130	07102140A	CCD 47. NF 25. VM	56289	SPR C069B250J473M OR EQUV
C 131	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 132	07101970A	CCD 33.0PF 1.0KVJ NPO	56289	SPRAGUE C030B102G330J EQV
C 133	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 134	07102380A	CTF 150.0UF 15.0VK	56289	SPRAGUE 196D157X9015MA3
C 141	07102150A	CMM 1.1NF 500. VJ SILV MI	84171	ARCO CM20E112J OR EQUIV.
C 142	07102150A	CMM 1.1NF 500. VJ SILV MI	84171	ARCO CM20E112J OR EQUIV.
C 202	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 203	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 205	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 206	07025080A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C 207	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 208	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CD00B102F180J
C 209	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 210	07101530A	CCD 6.8PF 500.0 V NPO+-1PF	72982	ERIE 801 NPO 6.8PF 1P500V
C 211	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 214	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 215	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 216	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 217	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 218	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 220	07101870A	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 1960335X0015
C 222	07102000A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 230D18224K OR EQ
C 223	07025400A	CCD 5.0NF 100.0 V +-20%	04171	ARCO #TCPR005 OR EQUAL
C 301	07101290A	CTF 47. UF 35. V	50423	KEMET 362D476M035AS
C 303	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 304	07100860A	CCD 68.0PF 500 V	90201	RMC TYPE CG
C 305	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 308	07102440A	CET 330.0UF 6.0 VK	56289	SPRAGUE 196D337X9006 MA3
C 309	07101530A	CCD 6.8PF 500.0 V NPO+-1PF	72982	ERIE 801 NPO 6.8PF 1P500V
C 401	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 402	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 403	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 404	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 405	07101280A	CYM 1.0UF 50.0 VK	56289	SPRAGUE 431P1059R5 OR EQV

Main P.C. Board (3045A and 3046A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
CR 101	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 102	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 201	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 202	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 203	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 401	05100530A	DGP 920A-6	04713	MOT
CR 402	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 403	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 404	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 505	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
CR 506	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
CR 801	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 802	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
F 2	19100060A	FUS 0.125A PICOFUSE PIGTAIL	75915	LITTELFUSE 1/8AMP 275.125
Q 101	10100781A	TRQ 40673 SEL FOR IDS	50423	BLI SEL PER 99-100225A
Q 102	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 103	10101210A	TRQ MPSH81 PNP 1 20 STO-92	04713	MOT. MPSA81350 1 2G 60
Q 104	10101210A	TRQ MPSH81 PNP 1 20 STO-92	04713	MOT. MPSA81350 1 2G 60
Q 105	10101210A	TRQ MPSH81 PNP 1 20 STO-92	04713	MOT. MPSA81350 1 2G 60
Q 201	10101221A	TRQ MPSH81 SEL BETA 25%MATCH	50423	BLI PER 99100165A
Q 202	10101221A	TRQ MPSH81 SEL BETA 25%MATCH	50423	BLI PER 99100165A
Q 203	10101210A	TRQ MPSH81 PNP 1 20 STO-92	04713	MOT. MPSA81350 1 2G 60
Q 204	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 205	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 206	10101210A	TRQ MPSH81 PNP 1 20 STO-92	04713	MOT. MPSA81350 1 2G 60
Q 301	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 302	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 303	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
R 101	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 102	12088650A	RFF 10.0 M 500.0MW F+- 1%	03888	PYF TYP PME-70
R 103	12125000A	RFF 100.0 K 250.0MW FT- 1%	16299	CGW RN55D 1003 F
R 104	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 105	12123940A	RFF 9.53K 250.0MW FT- 1%	16299	CGW RN55D 9531 F
R 106	09100050A	RVF 1.00K 0.5 WK CERMET	73138	HELIPOT 72PM
R 107	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 108	12123440A	RFF 2.80K 250.0MW FT- 1%	16299	CGW RN55D 2871 F
R 109	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 110	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 111	12122500A	RFF 332.0 250.0MW FT- 1%	16299	CGW RN55D 3320 F
R 112	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 113	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 114	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 115	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 116	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 117	12122600A	RFF 422.0 250.0MW FT- 1%	16299	CGW RN55D 4220 F
R 118	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 119	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 120	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 121	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 122	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 123	12123040A	RFF 1.10K 250.0MW FT- 1%	16299	CGW RN55D 1101 F
R 124	12122940A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 126	12123720A	RFF 5.62K 250.0MW FT- 1%	16299	CGW RN55D 5621 F
R 127	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 128	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 129	12122480A	RFF 316.0 250.0MW FT- 1%	16299	CGW RN55D 3160 F
R 130	12123680A	RFF 5.11K 250.0MW FT- 1%	16299	CGW RN55D 5111 F
R 131	12123800A	RFF 6.81K 250.0MW FT- 1%	16299	CGW RN55D 6811 F
R 132	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM

Main P.C. Board (3045A and 3046A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 133	12122400A	RFF 261.0 250.0MW FT- 1%	16299	CGW RN55D 2610 F
R 134	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 135	12127720A	RFF 563.6 250.0MW A	03888	PYROFILM PME60T9 563.6
R 136	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 137	12127710A	RFF 481.2 250.0MW A	03888	PYROFILM PME60T9 481.2
R 138	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 139	12127690A	RFF 329.0 250.0MW A	03888	PYROFILM PME60T9 329.0
R 140	12121680A	RFF 51.1 250.0MW FT- 1%	16299	CGW RN55D 52R3 F
R 141	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 142	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 143	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 144	12128150A	RFC 6.8 125.0MW J+- 5%	01121	A-B TYPE BB
R 145	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 146*	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 146*	12126460A	RCF 5.05 125.0MW F+- 1%	00327	WELWYN 4333 GR00972
R 146*	12127930A	RFC 3.6 125.0MW	01121	A-B TYPE BB
R 146*	12128090A	RFC 2.7 125.0MW J+- 5%	01121	A-B TYPE BB
R 146*	12128150A	RFC 6.8 125.0MW J+- 5%	01121	A-B TYPE BB
R 147	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 148	12123280A	RFF 1.91K 250.0MW FT- 1%	16299	CGW RN55D 1961 F
R 149	12122000A	RFF 100.0 250.0MW FT- 1%	16299	CGW RN55D 1000 F
R 150	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 151	12123880A	RFF 8.25K 250.0MW FT- 1%	16299	CGW RN55D 8251 F
R 160	12122800A	RFF 681.0 250.0MW FT- 1%	16299	CGW RN55D 6810 F
R 161	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 162	27011530A	THR-200 K+-10%	83186	VTF TYPE 22E9
R 201	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 203	12123320A	RFF 2.10K 250.0MW FT- 1%	16299	CGW RN55D 2151 F
R 204	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F
R 205	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F
R 206	12123400A	RFF 2.55K 250.0MW FT- 1%	16299	CGW RN55D 2611 F
R 207	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 208	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 209	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 210	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 211	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 212	12124280A	RFF 19.6 K 250.0MW FT- 1%	16299	CGW RN55D 1962 F
R 213	12123440A	RFF 2.80K 250.0MW FT- 1%	16299	CGW RN55D 2871 F
R 214	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 215	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 216	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 217	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 218	12122880A	RFF 825.0 250.0MW FT- 1%	16299	CGW RN55D 8250 F
R 219	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 220	12122560A	RFF 383.0 250.0MW FT- 1%	16299	CGW RN55D 3830 F
R 221	12123760A	RFF 6.19K 250.0MW FT- 1%	16299	CGW RN55D 6191 F
R 222	09100070A	RVC 5.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 223	12123680A	RFF 5.11K 250.0MW FT- 1%	16299	CGW RN55D 5111 F
R 224	12122560A	RFF 383.0 250.0MW FT- 1%	16299	CGW RN55D 3830 F
R 225	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 226	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 227	12122480A	RFF 316.0 250.0MW FT- 1%	16299	CGW RN55D 3160 F
R 228	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 230	12124400A	RFF 26.1 K 250.0MW FT- 1%	16299	CGW RN55D 2612 F
R 231	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 232	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 233	12124400A	RFF 26.1 K 250.0MW FT- 1%	16299	CGW RN55D 2612 F
R 234	12123180A	RFF 1.54K 250.0MW FT- 1%	16299	CGW RN55D 1541 F
R 235	12123080A	RFF 1.21K 250.0MW FT- 1%	16299	CGW RN55D 1211 F
R 236	12124000A	RFF 10.0 K 250.0MW FT- 1%	16299	CGW RN55D 1002 F
R 237	12123880A	RFF 8.25K 250.0MW FT- 1%	16299	CGW RN55D 8251 F

*Factory selected value.

Main P.C. Board (3045A and 3046A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 238	12125480A	RFF 316.0 K 500 MW F+-1%	16299	CGW RN60D 3163F
R 239*	09101200A	RVF 100.0K 250.0MW K CERMET	73138	HELIPOT 72XW VERT
R 240	12124480A	RFF 31.6 K 250.0MW FT- 1%	16299	CGW RN55D 3162 F
R 241*	09100930A	RVF 10.0K 500.0 MW K VERT	73138	HELIPOT 72XW 10K
R 242	12125480A	RFF 316.0 K 500 MW F+-1%	16299	CGW RN60D 3163F
R 243*	09100930A	RVF 10.0K 500.0 MW K VERT	73138	HELIPOT 72XW 10K
R 246	12122340A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 247*	09100940A	RVF 500.0 500.0MW K VERT	73138	HELIPOT 72XW 500
R 248	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 249	12125680A	RFF 511.0 K 500 MW F+-1%	16299	CGW RN60D 5113F
R 250	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 251	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 252	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 253	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 254	12125480A	RFF 316.0 K 500 MW F+-1%	16299	CGW RN60D 3163F
R 255†	12123680A	RFF 5.11K 250.0MW FT -1%	16299	CGW RN55D 5111 F
R 255¶	12124000A	RFF 10.0K 250.0MW FT -1%	16299	CGW RN55D 1002 F
R 256†	12124000A	RFF 10.0K 250.0MW FT -1%	16299	CGW RN55D 1002 F
R 256¶	12123680A	RFF 5.11K 250.0MW FT -1%	16299	CGW RN55D 5111 F
R 257*	09100930A	RVF 10.0K 500.0MW K VERT	73138	HELIPOT 72XW 10K
R 258	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 259	12121080A	RFF 12.1 250.0MW FT- 1%	16299	CGW RN55D 12P1 F
R 301	12123080A	RFF 1.21K 250.0MW FT- 1%	16299	CGW RN55D 1211 F
R 302	12121720A	RFF 56.2 250.0MW FT- 1%	16299	CGW RN55D 56R2 F
R 303	12122720A	RFF 562.0 250.0MW FT- 1%	16299	CGW RN55D 5620 F
R 304	12122160A	RFF 147.0 250.0MW FT- 1%	16299	CGW RN55D 1470 F
R 305	12122520A	RFF 348.0 250.0MW FT- 1%	16299	CGW RN55D 3480 F
R 306	12122600A	RFF 422.0 250.0MW FT- 1%	16299	CGW RN55D 4220 F
R 307	12122760A	RFF 619.0 250.0MW FT- 1%	16299	CGW RN55D 6190 F
R 309	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 310	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 311	12124280A	RFF 19.6 K 250.0MW FT- 1%	16299	CGW RN55D 1962 F
R 312	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 313	12122160A	RFF 147.0 250.0MW FT- 1%	16299	CGW RN55D 1470 F
R 314	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38P3 F
R 315	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 316	12123320A	RFF 2.10K 250.0MW FT- 1%	16299	CGW RN55D 2151 F
R 320	12123940A	RFF 9.53K 250.0MW FT- 1%	16299	CGW RN55D 9531 F
R 401	12121210A	RFF 16.5 250.0MW FT- 1%	16299	CGW RN55D 16R5 F
R 402	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 403	12125000A	RFF 100.0 K 250.0MW FT- 1%	16299	CGW RN55D 1003 F
R 801	12123720A	RFF 5.62K 250.0MW FT- 1%	16299	CGW RN55D 5621 F
R 802†	12123160A§	RFF 1.47K 500 MW F+-1%	16299	CGW RN55D 1471F
R 802†	12123180A§	RFF 1.54K 500 MW F+-1%	16299	CGW RN55D 1541F
R 802¶	12123200A	RFF 1.62K 500 MW F+-1%	16299	CGW RN55D 1621F
R 803†	13100161A§	RNF 99.0 METER COMP	50423	
R 803¶	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW RN55D 2870F
R 804	12123760A	RFF 6.19K 250.0MW FT- 1%	16299	CGW RN55D 6191 F
S 2	25100901A	SWC TOGGLE 3PDT PC MTG	09353	C+K 7301SYAV2 NON THD
S 4	25100760A	SWC TOG SPDT PC VERT NON THD	09353	C+K 7101 SY AV2 NON THD
S 5	25100750A	SWC TOG DPDT PC VERT NON THD	09353	C+K 7201 SY AV2 NON THD
S 6	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040

*Optionally available as internal adjustments. Ballantine part numbers are: R239, P/N 09101160A; R241, R243, and R257, P/N 09101240A; R247, P/N 09101250A.
†Used on 3045A.
¶Used on 3046A.

§When P/N 18-10026-1F is used for M201, R802 is 1.47k ohms and R803 is a temperature-compensating resistor network. When P/N 18-10037-1F is used for M201, R803 is not used--a short is used instead.

Main P.C. Board (3045A and 3046A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
S 1A	25100781A	SWC PART OF 25100771A	50423	CTS
S 1B	25100531C	SWC SECT 1&2 OF 25-10055-1C	11236	CTS SER 212 12 POS
S 1C	25100791A	SWC PART OF 25100771A	50423	
S 1D	25100731A	SWC PART OF 25100551E	11236	CTS
S 1E	25100541B	SWC SECT 3&4 OF 25100551C	50423	CTS SER 212 12 POS
S 1F	25100581B	SWC SECT 5 OF 2510055-1C	50423	CTS SER 212 12 POS
T 401	20100210A	TRX POWER (3045A)	08779	SIGNAL TRANS DPC-56-180
U 201	24094290A	ICP 8 LD MET CAN FCHD MA741C	07263	FCH U5B7741312
U 401	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FCH 78M12C
U 402	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FCH 78M12C
Z 401	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10
		OPTION MOD-05 (RECHARGEABLE BATTERY) ALSO INCLUDES:		
CR 501	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 502	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 503	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 504	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
Q 501	10100040A	TRQ MJE520 NPN 1 30 P77-03	04713	MOT 25 25
R 501	12124440A	RFF 28.7 K 250.0MW FT- 1%	16299	CGW RN55D 2872 F
R 502	09100950A	RVF 50.0 500.0MW M	73138	HELIPOT 72PM 50
R 503	12122240A	RFF 178.0 250.0MW FT- 1%	16299	CGW RN55D 1780 F
S 501	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040

Front Panel (3045A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	16100000A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5082-4440
J 1	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
M 201*	18100261F	MTR 3045A 1 MA 470 OHM 2%	50423	
M 201*	18100371F	MTR 3045A 1MA 470 OHM 2% TC	50423	MODUTEC 4.5IN SEL DAMPED
S 1	25100771B	SWC 3045A RANGE	11236	CTS BLT REV
S 10	25077860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #46256LF

Front Panel (3046A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	16100000A	LMP PAN GALLIUM ARSENIDE	28480	(H-P)-5082-4440
J 1	31033790A	CON UG=1094/U BNC, DAGE	29587	STATE ELECT. PARTS
M 201	18100101H	MTR 3036A 1MA FS 1%ACC.5%TR	32171	MODUTEC LOG/100B LIN-DB
R 601	09101041A	RVC 10.0 K 250.0MW MTAPER A	11263	CTS NS200 1/4BU .5PL SHFT
R 602	12122800A	RFF 681.0 250.0MW FT- 1%	16299	CGW RN55D 6810 F
S 601	09101041A	RVC 10.0 K 250.0MW MTAPER A	11263	CTS NS200 1/4BU .5PL SHFT

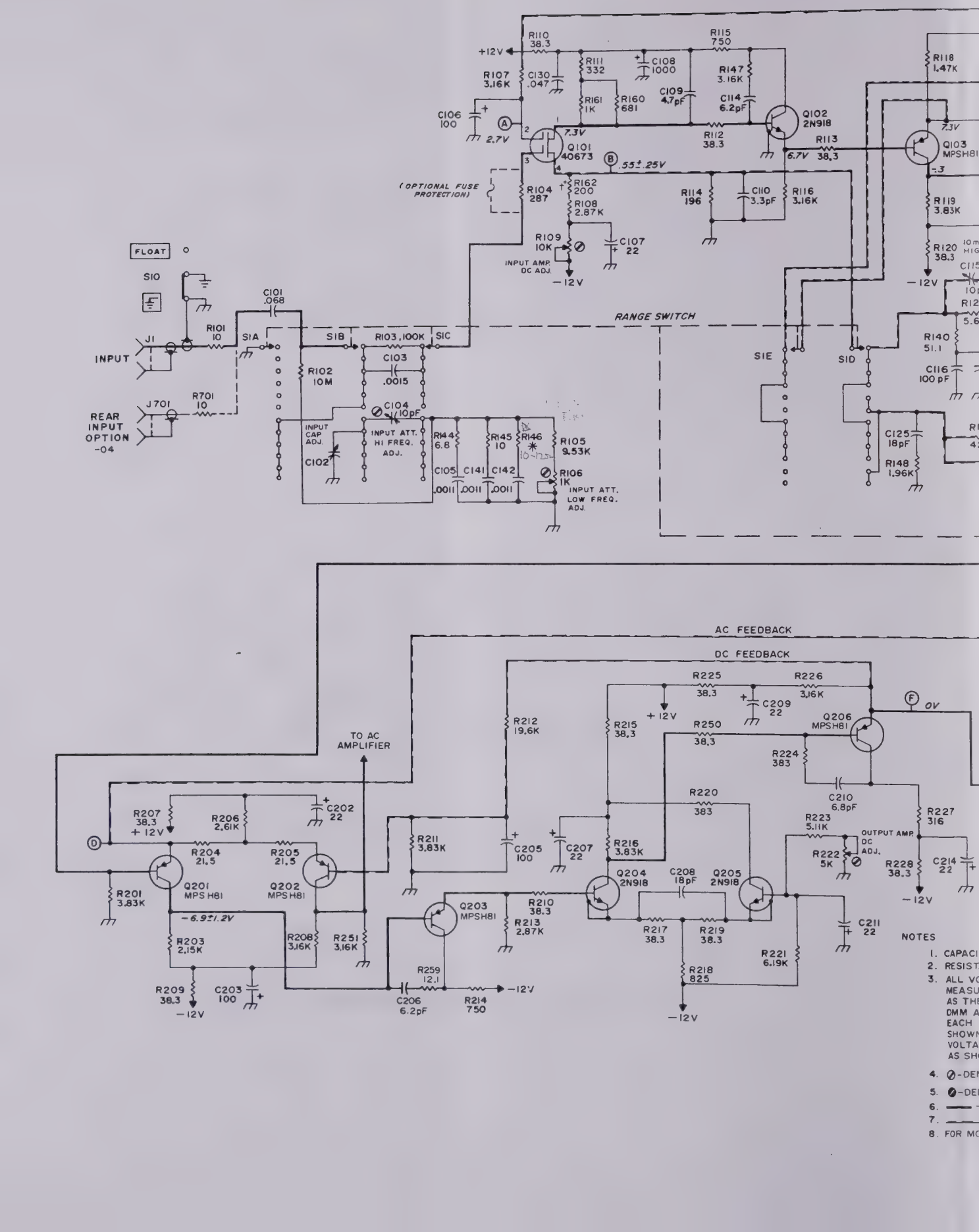
*Replace with same part number.

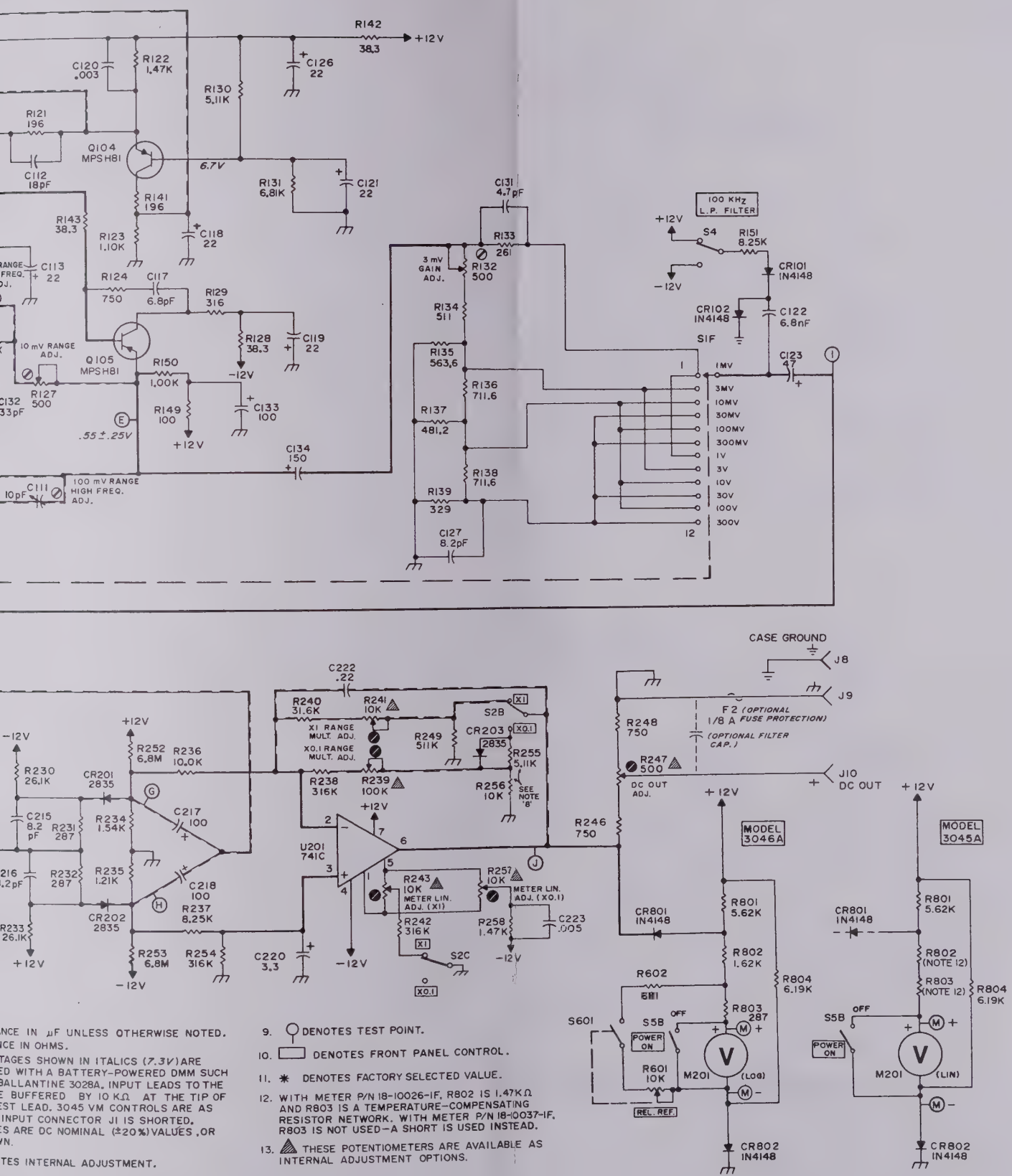
Rear Panel (3045A and 3046A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 1A	17100000A	FLE POWERLINE FILTER 250V	50423	F1740-410581 E.RODERSTEIN
C 1B	17100000A	FLE POWERLINE FILTER 250V	50423	F1740-410581 E.RODERSTEIN
F 1	19034100A	FUS 0.4 AMP. TYPE MDL	71400	BUSSMANN SLO-BLOW
J 2	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
J 3	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
J 5	31100000A	REC AC POWER	82389	SWITCHCRAFT
J 6	31073290A	BPS BINDING, NYLON, BLK.	83330	H.H.SMITH #1517
J 7	31082120A	BPS #1517, NYLON,WHITE	83330	H.H.SMITH
J 8	31100770A	BPS GND	83330	HH.SMITH 1518
J 9	31073290A	BPS BINDING, NYLON, BLK.	83330	H.H.SMITH #1517
J 10	31082020A	BPS #1517 RED	83330	H.H.SMITH
R 1	12127330A	RES 22.0 2.0 W K+-10%	01121	A-B TYP HB OR EQUIV
		OPTION MOD-04 (REAR INPUT) ALSO INCLUDES:		
J 701	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
R 701	12121000A	RES 10.0 250.0MW FT- 1%	16299	CGW RN550 10R0 F
		OPTION MOD-05 (RECHARGEABLE BATTERY) ALSO INCLUDES:		
	35100381F	BKT 3045A BAT SUP	50423	BLT
BT 501	85100390A	BAT 28.8 V .6 AMP-HRS	24446	GE PPS 2178 7325

Miscellaneous (3045A and 3046A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
	19100140A	FSH SQUARE MOLDED GRAY	75915	LITTLEFUSE 348-8-9-9
	33100000A	LNC LINE CORD SET 7FT.MLD	70903	BELDEN CORD SET 8N772
	37100121L	PLT DECORATIVE SIDE STRIP	50423	MODEL 3035A 2 REQD.
	40100160A	KNB 21 MM BLK 1/4 SHAFT	50423	ELMA SWISS 023-452 W/LINE
	40100240A	CAK 21MM BLK CAP	50423	ELMA C40-402
	40100040A	CAK 10MM BLACK	50423	ELMA SWISS 040-102
	40100290A	KNB 10MM BLK 4MM SHAFT W/LIN	50423	ELMA 021-232 WITH LINE
	40100340A	COV 10MM BLK WITH LINE	50423	ELMA SWISS 044-221
	44087880A	ASY BALL & FOOT ASY. 6.6 IN	21604	BUCKEYE MP 40008-11
	51100591M	COV 3045 SERIES BOT. BROWN	50423	BLT REV.
	51100601L	COV 3045 SERIES TOP BROWN	50423	BLT USE 43100184A MTL

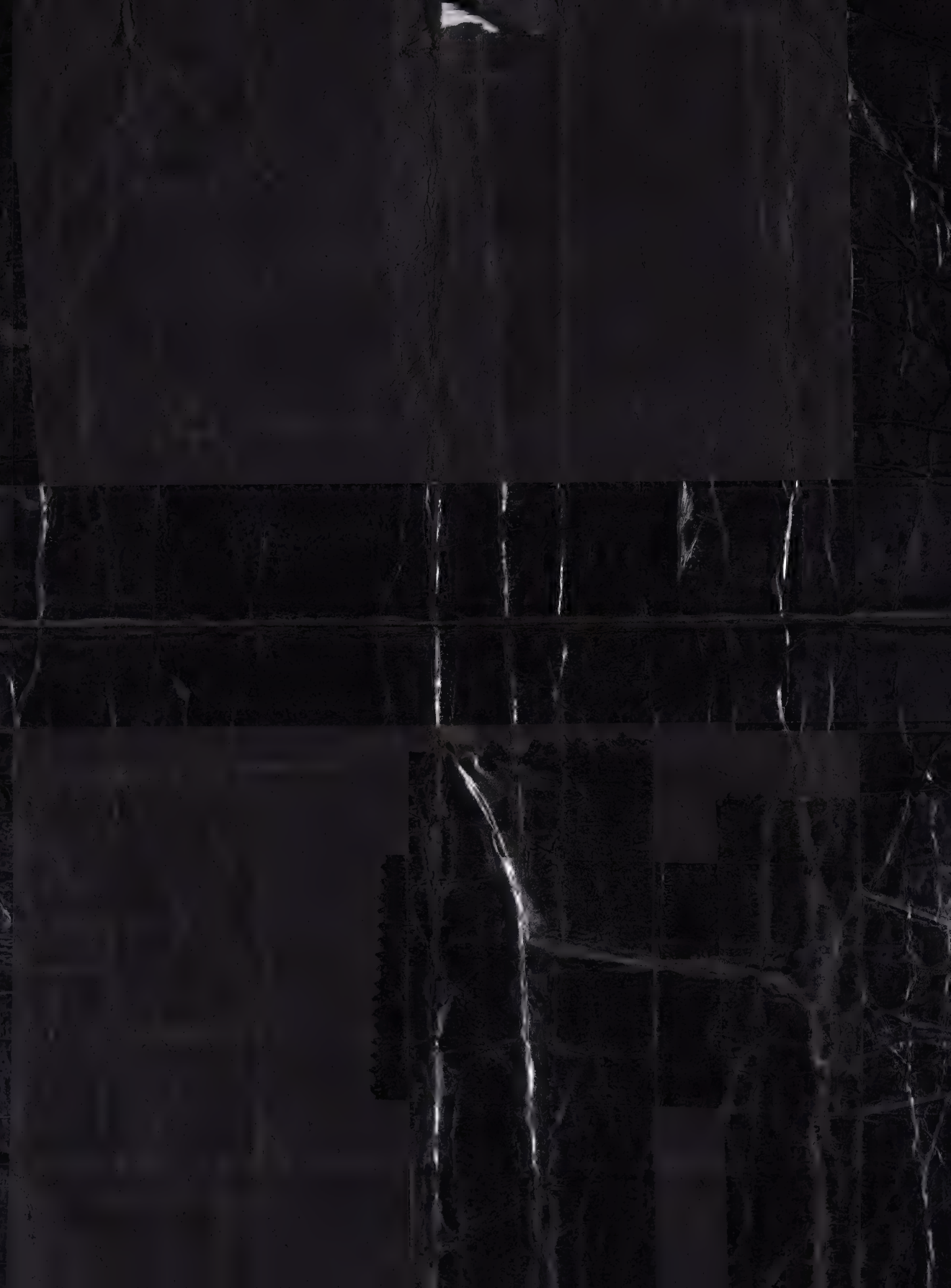

+12V
R110 38.3
R111 332
C108 1000
R115 750
R107 3.16K
C130 .047
R161 1K
R160 681
C109 4.7pF
C114 6.2pF
R147 3.16K
R118 1.47K
C106 100
2.7V
7.3V
Q101 40673
Q102 2N918
R112 38.3
6.7V
R113 38.3
Q103 MPSH81
.55±.25V
(OPTIONAL FUSE PROTECTION)
R104 287
R162 200
R108 2.87K
R114 196
C110 3.3pF
R116 3.16K
R119 3.83K
R109 10K
INPUT AMP. DC ADJ.
C107 22
R120 38.3
-12V
FLOAT
S10
C101 .068
RANGE SWITCH
J1
INPUT
R101 10
S1A
S1B
R103, 100K
S1C
S1E
S1D
R102 10M
C103 .0015
J701
R701 10
REAR INPUT OPTION -04
C104 10pF
INPUT CAP. ADJ.
C102
INPUT ATT. HI FREQ. ADJ.
R144 6.8
R145 10
R146
R105 9.53K
C105 .0011
C141 .0011
C142 .0011
R106 1K
INPUT ATT. LOW FREQ. ADJ.
R140 51.1
C116 100 pF
C125 18pF
R148 1.96K
AC FEEDBACK
DC FEEDBACK
R225 38.3
R226 3.16K
C209 22
+12V
F
0V
R212 19.6K
R215 38.3
R250 38.3
Q206 MPSH81
R224 383
C210 6.8pF
R220 383
R223 5.11K
OUTPUT AMP. DC ADJ.
R222 5K
R227 316
R228 38.3
C214 22
TO AC AMPLIFIER
R207 38.3 +12V
R206 2.61K
C202 22
D
R204 21.5
R205 21.5
Q201 MPSH81
Q202 MPSH81
R211 3.83K
C205 100
C207 22
R216 3.83K
Q204 2N918
C208 18pF
Q205 2N918
R201 3.83K
-6.9±1.2V
Q203 MPSH81
R210 38.3
R213 2.87K
R217 38.3
R219 38.3
C211 22
R203 2.15K
R208 3.16K
R251 3.16K
R221 6.19K
R259 12.1
R218 825
R209 38.3
C203 100
C206 6.2pF
R214 750
NOTES
1. CAPACI
2. RESIST
3. ALL VO MEASU AS THE DMM A EACH SHOWN VOLTA AS SH
4. Ø-DE
5. Ø-DE
6. —
7. —
8. FOR MO



NCE IN μF UNLESS OTHERWISE NOTED.
NCE IN OHMS.
TAGES SHOWN IN ITALICS (7.3V) ARE
ED WITH A BATTERY-POWERED DMM SUCH
BALLANTINE 3028A. INPUT LEADS TO THE
E BUFFERED BY 10 KΩ AT THE TIP OF
ST LEAD. 3045 VM CONTROLS ARE AS
INPUT CONNECTOR J1 IS SHORTED.
S ARE DC NOMINAL (±20%) VALUES, OR
N.
TES INTERNAL ADJUSTMENT.
TES EXTERNALLY ACCESSIBLE ADJUSTMENT.
ENOTES MAIN SIGNAL PATH.
-DENOTES FEEDBACK PATH.
EL 3046A- R255 IS 10.0K AND R256 IS 5.11K.

9. ○ DENOTES TEST POINT.
10. ▭ DENOTES FRONT PANEL CONTROL.
11. ✱ DENOTES FACTORY SELECTED VALUE.
12. WITH METER P/N 18-10026-1F, R802 IS 1.47KΩ AND R803 IS A TEMPERATURE-COMPENSATING RESISTOR NETWORK. WITH METER P/N 18-10037-1F, R803 IS NOT USED—A SHORT IS USED INSTEAD.
13. ⧋ THESE POTENTIOMETERS ARE AVAILABLE AS INTERNAL ADJUSTMENT OPTIONS.

Figure 6-1. 3045A and 3046A, Schematic Diagram



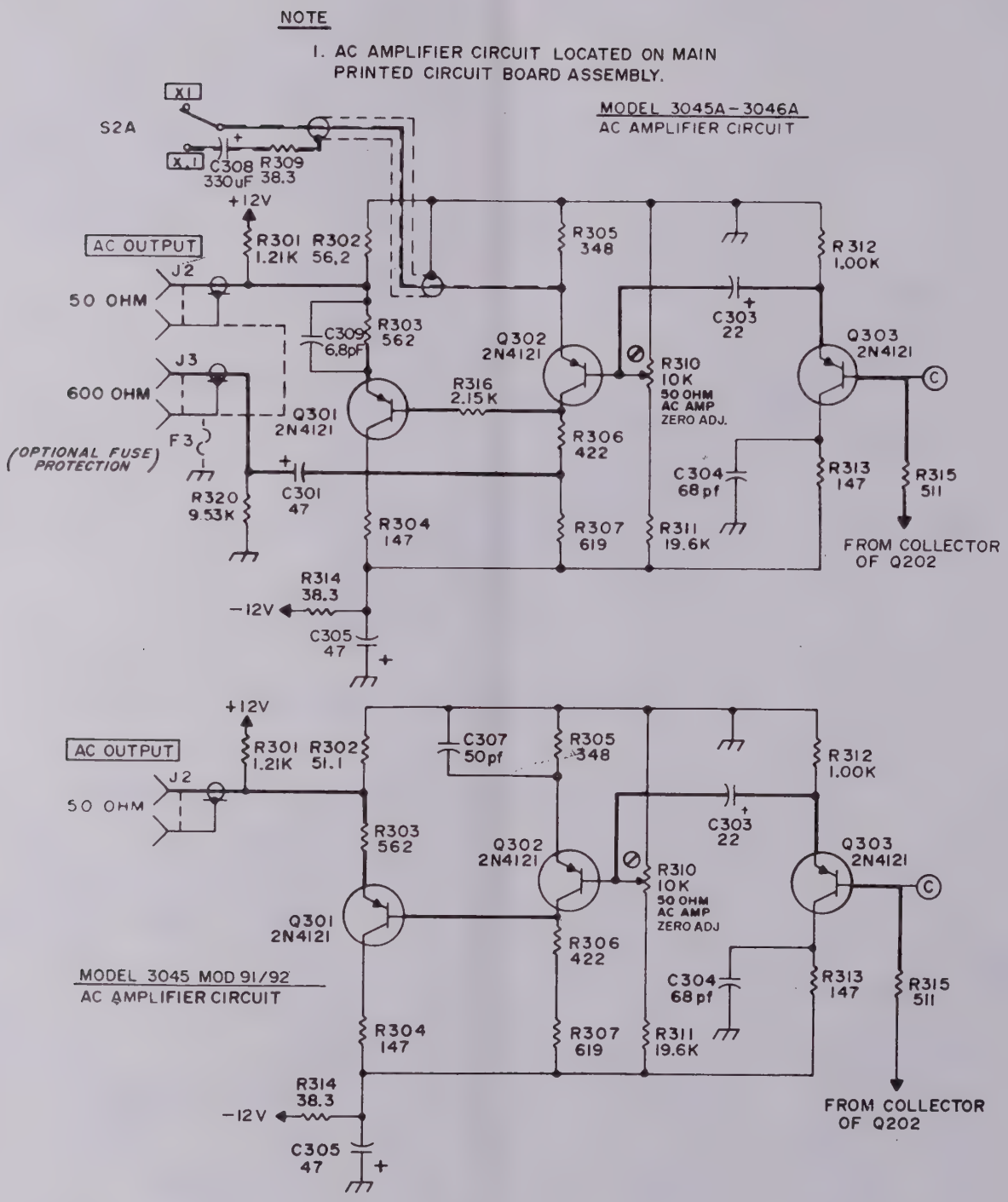
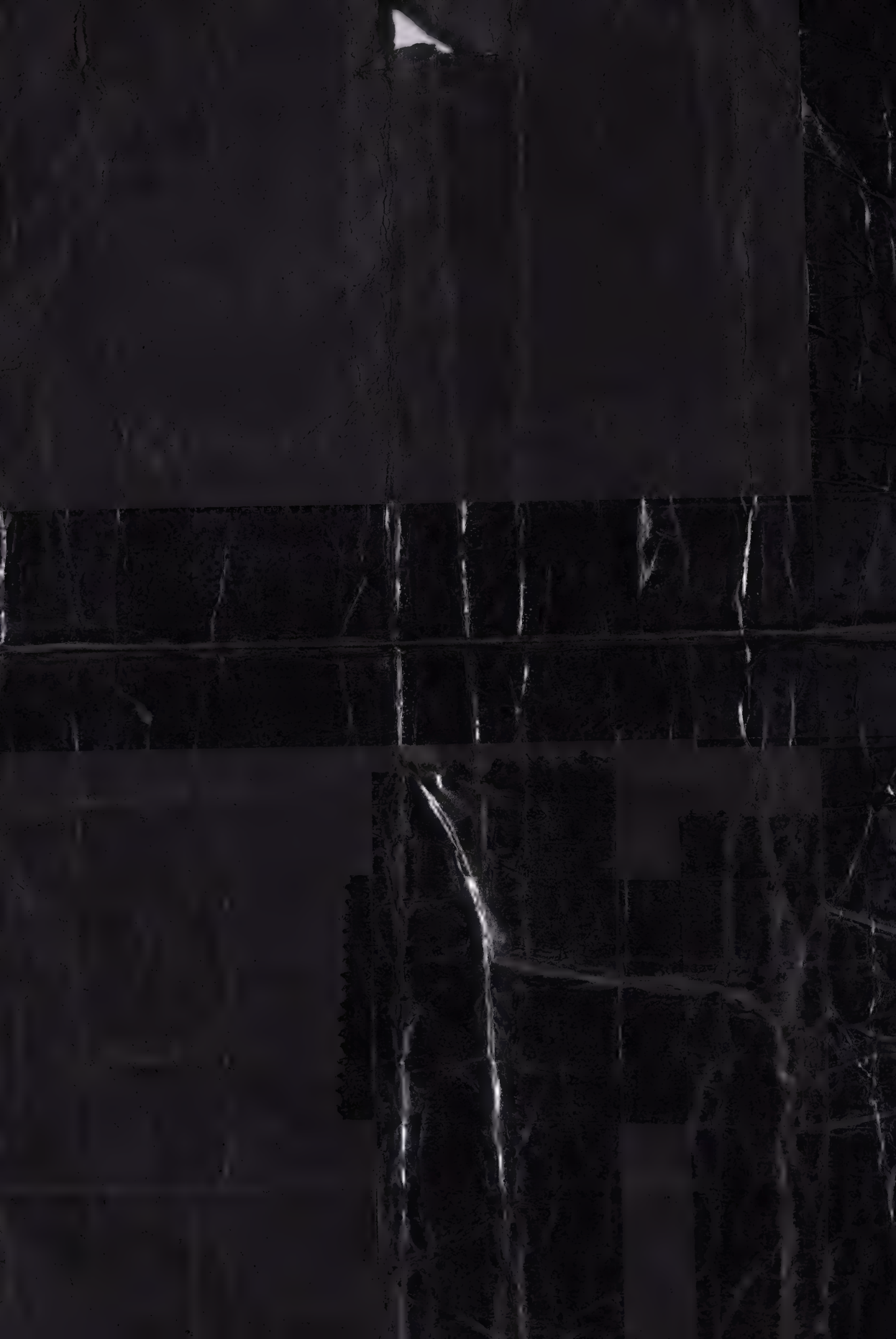
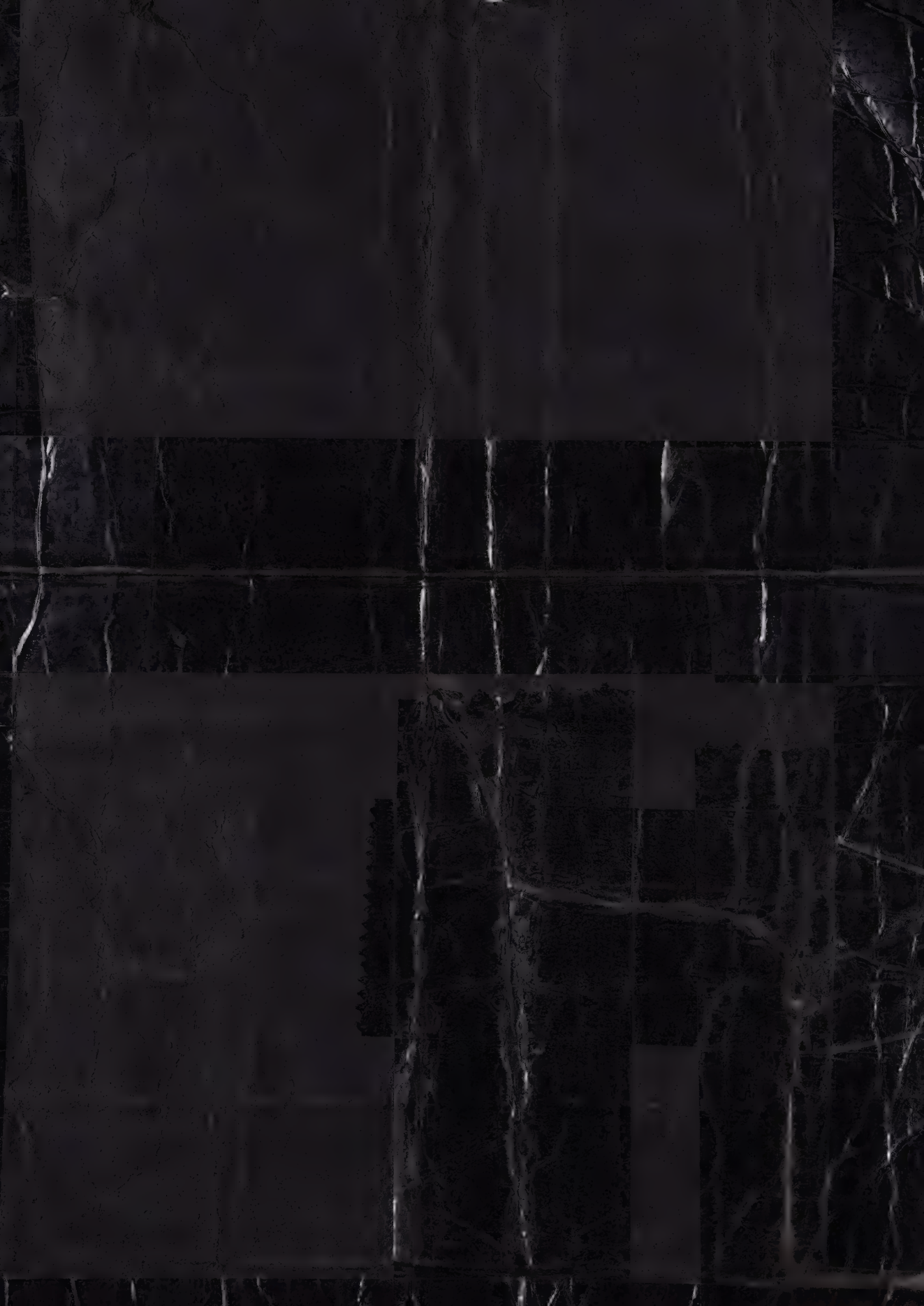
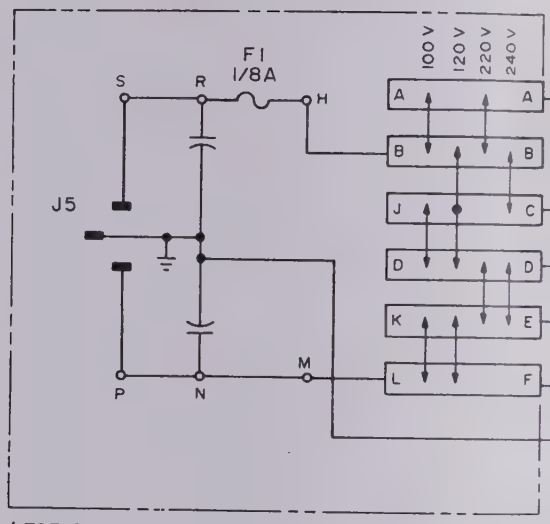


Figure 6-2. 3045A and 3046A, AC Amplifier, Schematic Diagram



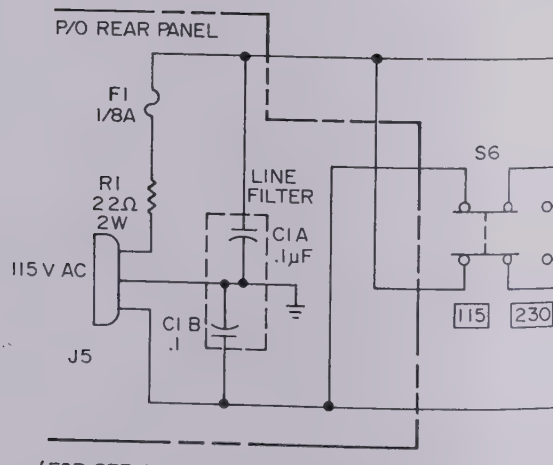




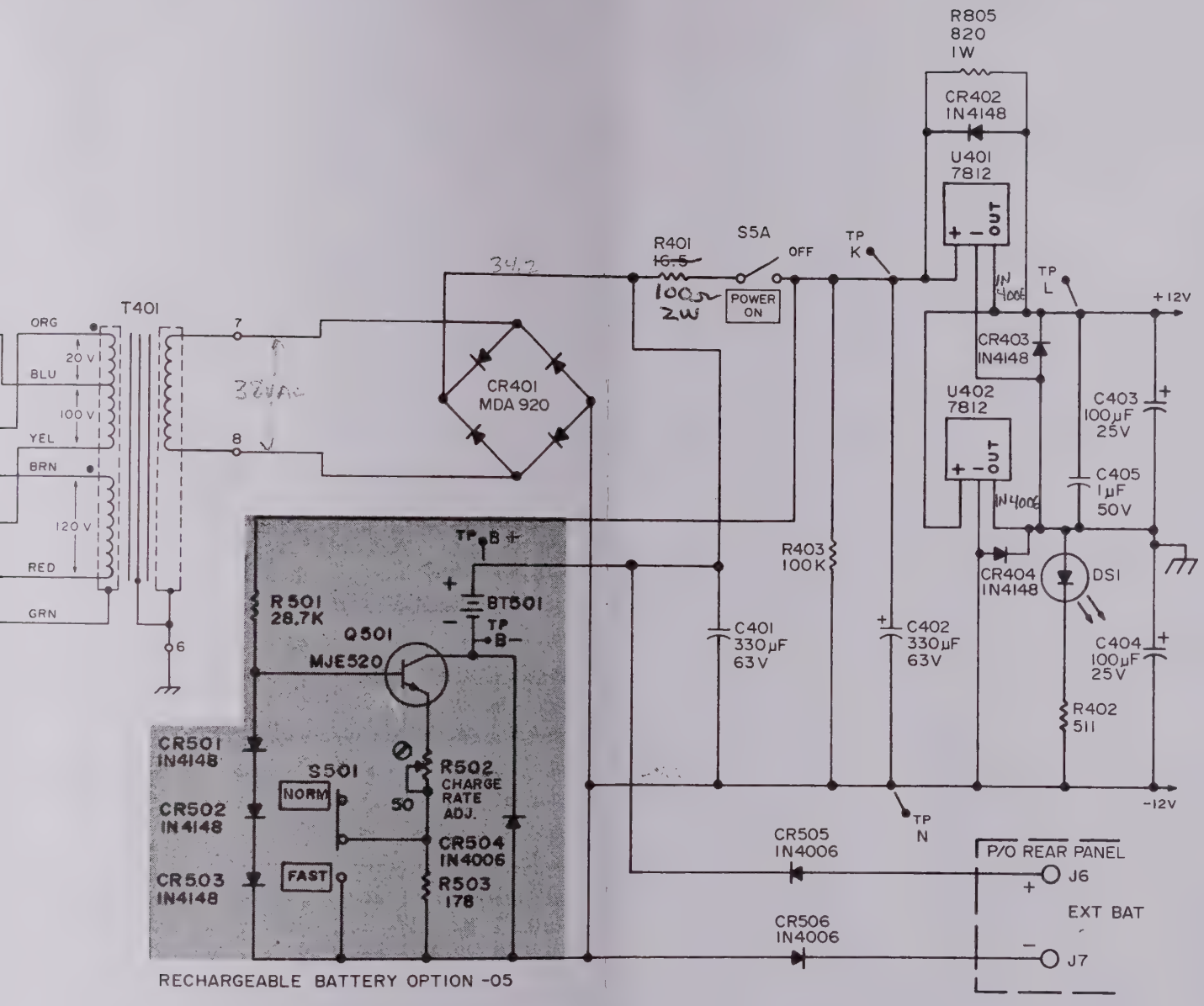
(FOR SERIAL NO. PREFIX 050–)

NOTES:

1. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL RESISTOR VALUES ARE IN OHMS.



(FOR SERIAL NO. PREFIX 020–)



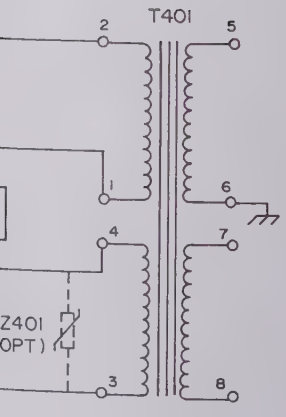


Figure 6-3. 3045A and 3046A, Power Supply, Schematic Diagram

Main P.C. Board (3015A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 101	07101760A	CCD 50.0NF 600.0 VT +80-20	71590	CTL DD 503
C 103	07095740A	CCD 1.5NF 1.0KV +-10%	71590	CTL TYP DD-152
C 104	07101780A	CVP 10.0PF 750.0 VT 2-10PF	50423	JACKSON BROS. 5640/PM
C 105	07022550A	CMM 3.3NF 500 V J 5%	84171	ARCO TYPE CM-20-E-332-J
C 106	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 107	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 108	07078330A	CEA1000 UF 16 V T	73445	AMPEREX C437AR/S1000
C 109	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 110	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 111	07022220A	CMM 10 PF 500 V J 5%	84171	ARCO TYPE CM15-E-010J
C 112	07101800A	CCD 18.0PF 1.0KV J NPO	56289	SPRAGUE C0G0B102F180J
C 113	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 114	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 115	07102590A	CCT 2.7PF 500.0 VJ	95121	QUALITY COMP TYP QC OR EQ
C 116	07095800A	CDD 100 PF J 5%	56289	SPG TYP 10TCC-T10
C 117	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 118	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 119	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 120	07102360A	CCD 3. NF 1. KVK	56289	SPRAGUE C016B102K302K
C 121	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 123	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 125	07101800A	CCD 18.0PF 1.0KV J NPO	56289	SPRAGUE C0G0B102F180J
C 126	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 127	07101800A	CCD 18.0PF 1.0KV J NPO	56289	SPRAGUE C0G0B102F180J
C 130	07102140A	CCD 47. NF 25. VM	56289	SPR C069B250J473M OR EQUV
C 131	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 132	07101970A	CCD 33.0PF 1.0KV J NPO	56289	SPRAGUE C030B102G330J EQV
C 133	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 134	07102380A	CTF 150.0UF 15.0VK	56289	SPRAGUE 196D157X9015MA3
C 135	07101990A	CCD 27.0PF 1.0KV J NPO	56289	SPRAG C030B102G270J OR EQ
C 202	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 203	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 205	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 206	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 207	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 208	07101800A	CCD 18.0PF 1.0KV J NPO	56289	SPRAGUE C0G0B102F180J
C 209	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 210	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 211	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 214	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 215	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 216	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 217	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 218	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 220	07101870A	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 1960335X0015
C 222	07102000A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 230D18224K OR EQ
C 301	07101290A	CTF 47. UF 35. V	50423	KEMET 362D476M035AS
C 303	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 305	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 306	07081160A	CCT 15 PF 500 V J 5%	95121	QUALITY COMPONENTS
C 307	07022970A	CMD 120 PF 500 V T	84171	ARCO DM-15-121-K
C 401	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 402	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 403	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 404	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 405	07101280A	CYM 1.0UF 50.0 VK	56289	SPRAGUE 431P1059R5 OR EQV
CR 201	05100210A	DGP 5082-2835 LOW DEF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 202	05100210A	DGP 5082-2835 LOW DEF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 401	05100530A	DGP 920A-6	04713	MOT
Q 101	10100781A	TRQ 40673 SEL FOR IDS	50423	BLT SEL PER 99-100225A
Q 102	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20

Main P.C. Board (3015A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
Q 103	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 104	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 105	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 201*	10100771A	TRQ 2N4121 PNP	50423	5 450M 150
Q 202*	10100771A	TRQ 2N4121 PNP	50423	5 450M 150
Q 203	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 204	10080550A	TRQ 2N918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 205	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 206	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 302	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
R 101	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 102	12088650A	PFF 10.0 M 500.0MW F+- 1%	03888	PYF TYP PME-70
R 103	12125000A	RFF 100.0 K 250.0MW FT- 1%	16299	CGW RN55D 1003 F
R 104	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 105	12124000A	RFF 10.0 K 250.0MW FT- 1%	16299	CGW RN55D 1002 F
R 107	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 108	12123440A	RFF 2.80K 250.0MW FT- 1%	16299	CGW RN55D 2871 F
R 109	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 110	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 111	12122880A	RFF 825.0 250.0MW FT- 1%	16299	CGW RN55D 8250 F
R 112	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 113	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 114	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 115	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 116	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 117	12122600A	RFF 422.0 250.0MW FT- 1%	16299	CGW RN55D 4220 F
R 118	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 119	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 120	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 121	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 122	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 123	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 124	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 126	12123720A	RFF 5.62K 250.0MW FT- 1%	16299	CGW RN55D 5621 F
R 127	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 128	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 129	12122480A	RFF 316.0 250.0MW FT- 1%	16299	CGW RN55D 3160 F
R 130	12123680A	RFF 5.11K 250.0MW FT- 1%	16299	CGW RN55D 5111 F
R 131	12123800A	RFF 6.81K 250.0MW FT- 1%	16299	CGW RN55D 6811 F
R 133	12122400A	RFF 261.0 250.0MW FT- 1%	16299	CGW RN55D 2610 F
R 134	12122860A	RFF 787.0 250.0MW FT- 1%	16299	CGW RN55D 7870 F
R 135	12127720A	RFF 563.6 250.0MW A	03888	PYROFILM PME60T9 563.6
R 136	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 137	12127710A	RFF 481.2 250.0MW A	03888	PYROFILM PME60T9 481.2
R 138	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 139	12127690A	RFF 329.0 250.0MW A	03888	PYROFILM PME60T9 329.0
R 140	12122000A	RFF 100.0 250.0MW FT- 1%	16299	CGW RN55D 1000 F
R 141	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 142	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 143	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 144†	12127930A	RFC 3.6 125.0MW	01121	A-B TYPE BB
R 144†	12128200A	RFC 5.1 125.0MW J+-5%	01121	A-B TYPE BB
R 144†	12128210A	RFC 6.2 125.0MW J+-5%	01121	A-B TYPE BB
R 147	12124520A	RFF 34.8 K 250.0MW FT- 1%	16299	CGW RN55D 3482 F
R 148	12123280A	RFF 1.91K 250.0MW FT- 1%	16299	CGW RN55D 1961 F
R 149	12122000A	RFF 100.0 250.0MW FT- 1%	16299	CGW RN55D 1000 F
R 150	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 201	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 203	12123320A	RFF 2.10K 250.0MW FT- 1%	16299	CGW RN55D 2151 F
R 204	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F
R 205	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F

*Beta grouped within 25%.
†Factory selected value.

Main P.C. Board (3015A) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 206	12123400A	RES 2.55K 250.0MW FT= 1%	16299	CGW RN55D 2611 F
R 207	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 208	12123480A	RES 3.16K 250.0MW FT= 1%	16299	CGW RN55D 3161 F
R 209	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 210	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 211	12123560A	RES 3.83K 250.0MW FT= 1%	16299	CGW RN55D 3831 F
R 212	12124280A	RES 19.6 K 250.0MW FT= 1%	16299	CGW RN55D 1962 F
R 213	12123440A	RES 2.80K 250.0MW FT= 1%	16299	CGW RN55D 2871 F
R 214	12122840A	RES 750.0 250.0MW FT= 1%	16299	CGW RN55D 7500 F
R 215	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 216	12123560A	RES 3.83K 250.0MW FT= 1%	16299	CGW RN55D 3831 F
R 217	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 218	12122880A	RES 825.0 250.0MW FT= 1%	16299	CGW RN55D 8250 F
R 219	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 220	12122560A	RES 383.0 250.0MW FT= 1%	16299	CGW RN55D 3830 F
R 221	12123760A	RES 6.19K 250.0MW FT= 1%	16299	CGW RN55D 6191 F
R 222	09100020A	RVC 5.0 K 0.5 WK +=10%	73138	HEL TYP 72PM
R 223	12123680A	RES 5.11K 250.0MW FT= 1%	16299	CGW RN55D 5111 F
R 224	12122560A	RES 383.0 250.0MW FT= 1%	16299	CGW RN55D 3830 F
R 225	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 226	12123480A	RES 3.16K 250.0MW FT= 1%	16299	CGW RN55D 3161 F
R 227	12122480A	RES 316.0 250.0MW FT= 1%	16299	CGW RN55D 3160 F
R 228	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 230	12124400A	RES 26.1 K 250.0MW FT= 1%	16299	CGW RN55D 2612 F
R 231	12122440A	RES 287.0 250.0MW FT= 1%	16299	CGW RN55D 2870 F
R 232	12122440A	RES 287.0 250.0MW FT= 1%	16299	CGW RN55D 2870 F
R 233	12124400A	RES 26.1 K 250.0MW FT= 1%	16299	CGW RN55D 2612 F
R 234	12123180A	RES 1.54K 250.0MW FT= 1%	16299	CGW RN55D 1541 F
R 235	12123080A	RES 1.21K 250.0MW FT= 1%	16299	CGW RN55D 1211 F
R 236	12124000A	RES 10.0 K 250.0MW FT= 1%	16299	CGW RN55D 1002 F
R 237	12123880A	RES 8.25K 250.0MW FT= 1%	16299	CGW RN55D 8251 F
R 240	12124480A	RES 31.6 K 250.0MW FT= 1%	16299	CGW RN55D 3162 F
R 241*	09100930A	RVC 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 243*	09100930A	RVC 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 250	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 252	12010020A	RES 6.8 M 500.0MW K+=10%	01121	A-B TYP EB
R 253	12010020A	RES 6.8 M 500.0MW K+=10%	01121	A-B TYP EB
R 254	12125480A	RES 316.0 K 500 MW F+=1%	16299	CGW RN60D 3163F
R 305	12122520A	RES 348.0 250.0MW FT= 1%	16299	CGW RN55D 3480 F
R 306	12122600A	RES 422.0 250.0MW FT= 1%	16299	CGW RN55D 4220 F
R 307	12122760A	RES 619.0 250.0MW FT= 1%	16299	CGW RN55D 6190 F
R 310	12123560A	RES 3.83K 250.0MW FT= 1%	16299	CGW RN55D 3831 F
R 311	12124280A	RES 19.6 K 250.0MW FT= 1%	16299	CGW RN55D 1962 F
R 314	12121560A	RES 38.3 250.0MW FT= 1%	16299	CGW RN55D 38R3 F
R 315	12122680A	RES 511.0 250.0MW FT= 1%	16299	CGW RN55D 5110 F
R 320	12123940A	RES 9.53K 250.0MW FT= 1%	16299	CGW RN55D 9531 F
R 401	12121480A	F	16299	CGW RN55D 31R6 F
R 402	12122680A	RES 511.0 250.0MW FT= 1%	16299	CGW RN55D 5110 F
R 403	12125000A	RES 100.0 K 250.0MW FT= 1%	16299	CGW RN55D 1003 F
R 802	12123280A	RES 1.91K 250.0MW FT= 1%	16299	CGW RN55D 1961 F
S 6	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040
S 1A	25100781A	SWC PART OF 25100771A	50423	CTS
S 1B	25100531C	SWC SECT 1&2 OF 25-10055-1C	11236	CTS SER 212 12 POS
S 1C	25100791A	SWC PART OF 25100771A	50423	
S 1D	25100731A	SWC PART OF 25100551E	11236	CTS
S 1E	25100541B	SWC SECT 3&4 OF 25100551C	50423	CTS SER 212 12 POS
S 1F	25100581B	SWC SECT 5 OF 2510055-1C	50423	CTS SER 212 12 POS
T 401	20100210A	TRX POWER (3045A)	08779	SIGNAL TRANS DPC-56-180
U 201	24094290A	ICP 8 LD MET CAN FCHD	07263	FCHLD U5B7741312
U 401	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FCHLD 78M12C
U 402	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FCHLD 78M12C
Z 401	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10

*Optionally available as internal adjustments. Ballantine part number is 09101240A.

Front Panel (3015A)

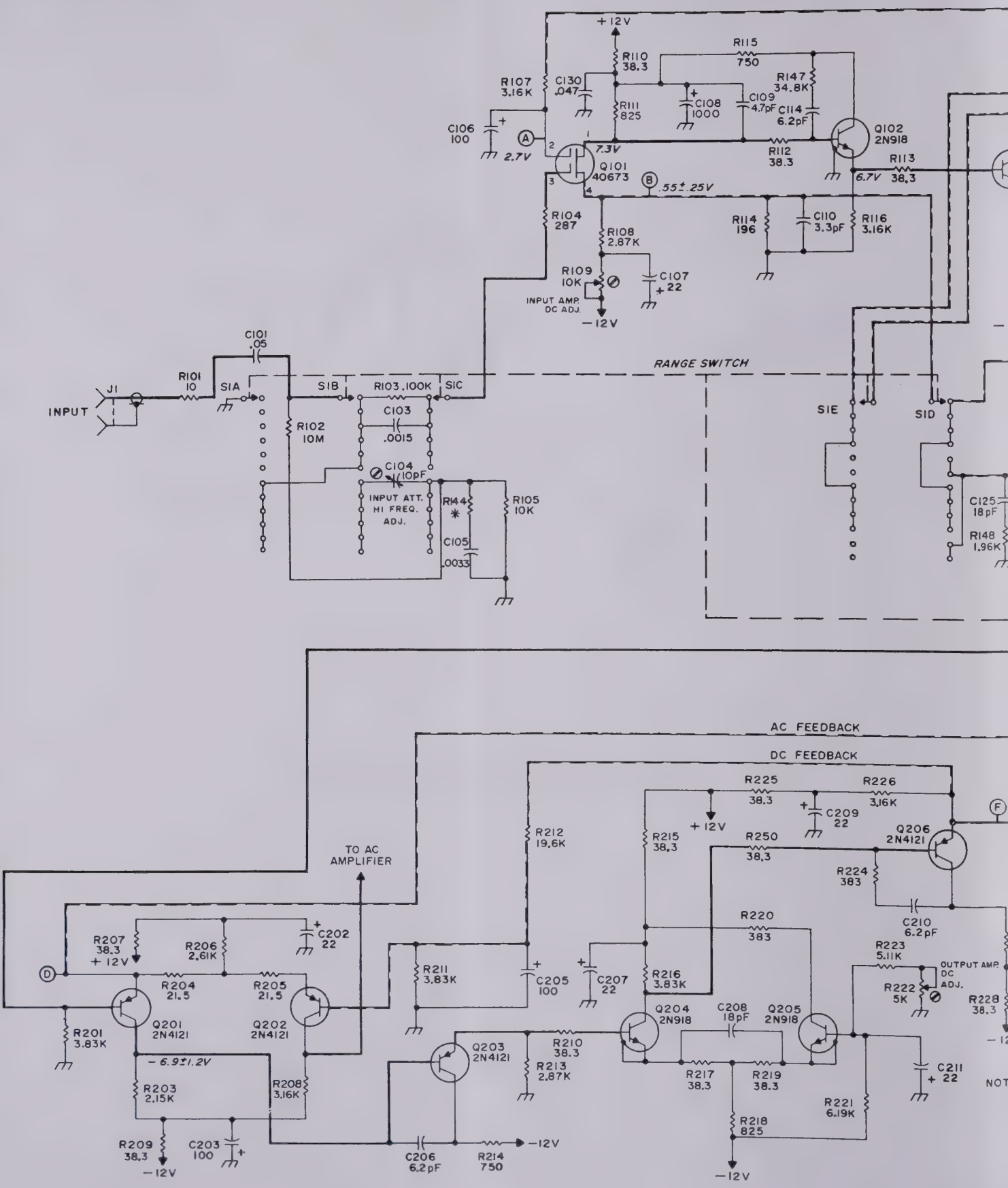
SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	16100000A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5082-4440
J 1	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
M 201	18100271G	MTR 3015/VM77E 1MA FS	50423	BLI REV. MODITEC 4.15 LIN
S 1	25100771B	SWC 3045A RANGE	11236	CTS BLI REV
S 5	25100610A	SWC TOG DPDT WIRE FLAT HOLE	09353	C+K 7201PYZB

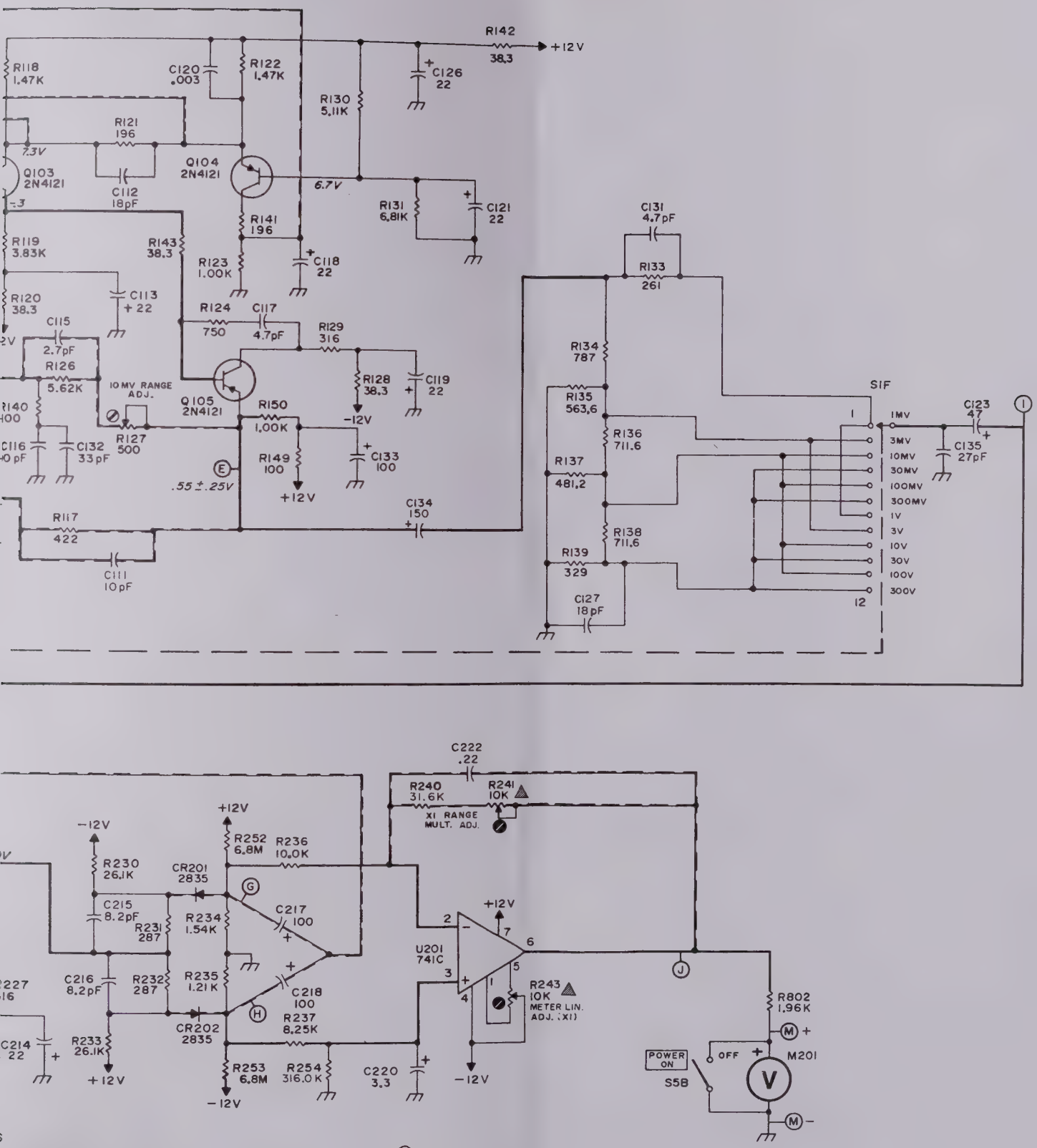
Rear Panel (3015A)

C 1A	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
C 1B	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
F 1	19028070A	FUS 1/8 A SLO-BLO	75915	LTF 313.125, 3 AG
J 3	31033790A	CON UG-1094/U BNC, DAGE	29587	STATE ELECT PARTS
J 5	31100000A	REC AC POWER	82389	SWITCHCRAFT
R 1	12127330A	RES 22.0 2.0 W K+-10%	01121	A-B TYP HB OR EQUIV

Miscellaneous (3015A)

	19100140A	FSH SQUARE MOLDED GRAY	75915	LITTLEFUSE 348-8-9-9
	33100000A	LNC LINE CORD SET 7FT.MLD	70903	BELDEN CORD SET BN772
	37100121L	PLT DECORATIVE SIDE STRIP	50423	MODEL 3035A 2 REQD.
	40100160A	KNB 21 MM BLK 1/4 SHAFT	50423	ELMA SWISS 023-452 W/LINE
	40100240A	CAK 21MM BLK CAP	50423	ELMA 040-402
	51100321P	COV 3045 SERIES BOT. CHARCOL	50423	BLI USE 431000448 MTL
---	51100311M	COV 3045 SER TOP	50423	


+12V
R110 38.3
R115 750
R107 3.16K
C130 .047
R111 825
C108 1000
C109 4.7pF
C114 6.2pF
R147 34.8K
C106 100
2.7V
7.3V
Q101 40673
Q102 2N918
R112 38.3
6.7V
R113 38.3
.55±.25V
R104 287
R108 2.87K
R114 196
C110 3.3pF
R116 3.16K
R109 10K
C107 22
INPUT AMP. DC ADJ.
-12V
C101 .05
RANGE SWITCH
INPUT
J1
R101 10
S1A
S1B
R103, 100K
S1C
S1E
S1D
R102 10M
C103 .0015
C104 10pF
INPUT ATT. HI FREQ. ADJ.
R144
R105 10K
C105 .0033
C125 18pF
R148 1.96K
AC FEEDBACK
DC FEEDBACK
TO AC AMPLIFIER
R225 38.3
R226 3.16K
C209 22
+12V
R212 19.6K
R215 38.3
R250 38.3
Q206 2N4121
R224 383
C210 6.2pF
R220 383
R223 5.11K
OUTPUT AMP. DC ADJ.
R222 5K
R228 38.3
R207 38.3 +12V
R206 2.61K
C202 22
R204 21.5
R205 21.5
R211 3.83K
C205 100
C207 22
R216 3.83K
Q201 2N4121
Q202 2N4121
Q204 2N918
C208 18pF
Q205 2N918
R201 3.83K
-6.9±1.2V
Q203 2N4121
R210 38.3
R213 2.87K
R217 38.3
R219 38.3
C211 22
R203 2.15K
R208 3.16K
R221 6.19K
R218 825
R209 38.3
C203 100
C206 6.2pF
R214 750
-12V



1. CAPACITANCE IN μF UNLESS OTHERWISE NOTED.
2. RESISTANCE IN OHMS.
3. ALL VOLTAGES SHOWN IN ITALICS (*7.3V*) ARE MEASURED WITH A BATTERY POWERED DMM SUCH AS THE BALLANTINE 3028A. INPUT LEADS TO THE DMM ARE BUFFERED BY 10KΩ AT THE TIP OF EACH TEST LEAD. 3015A,VM77-E VM CONTROLS ARE AS SHOWN. INPUT CONNECTOR J1 IS SHORTED. VOLTAGES ARE DC NOMINAL (±20%) VALUES, OR AS SHOWN.
4. ⊘ - DENOTES INTERNAL ADJUSTMENT.
5. ⊘ - DENOTES EXTERNALLY ACCESSIBLE ADJUSTMENT.
6. ——— - DENOTES MAIN SIGNAL PATH.
7. ——— - DENOTES FEEDBACK PATH.
8. ○ DENOTES TEST POINT.
9. ▭ DENOTES FRONT PANEL CONTROL.
10. ✳ DENOTES FACTORY SELECTED VALUE.
11. ⚠ THESE POTENTIOMETERS ARE AVAILABLE AS INTERNAL ADJUSTMENT OPTIONS.

Figure 6-4. 3015A, Schematic Diagram

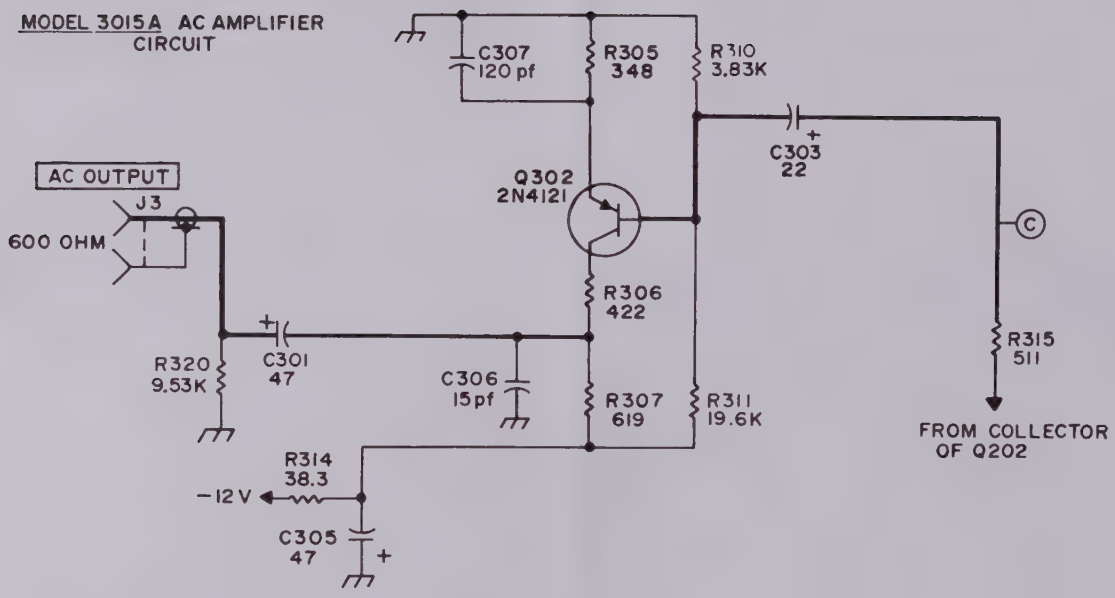
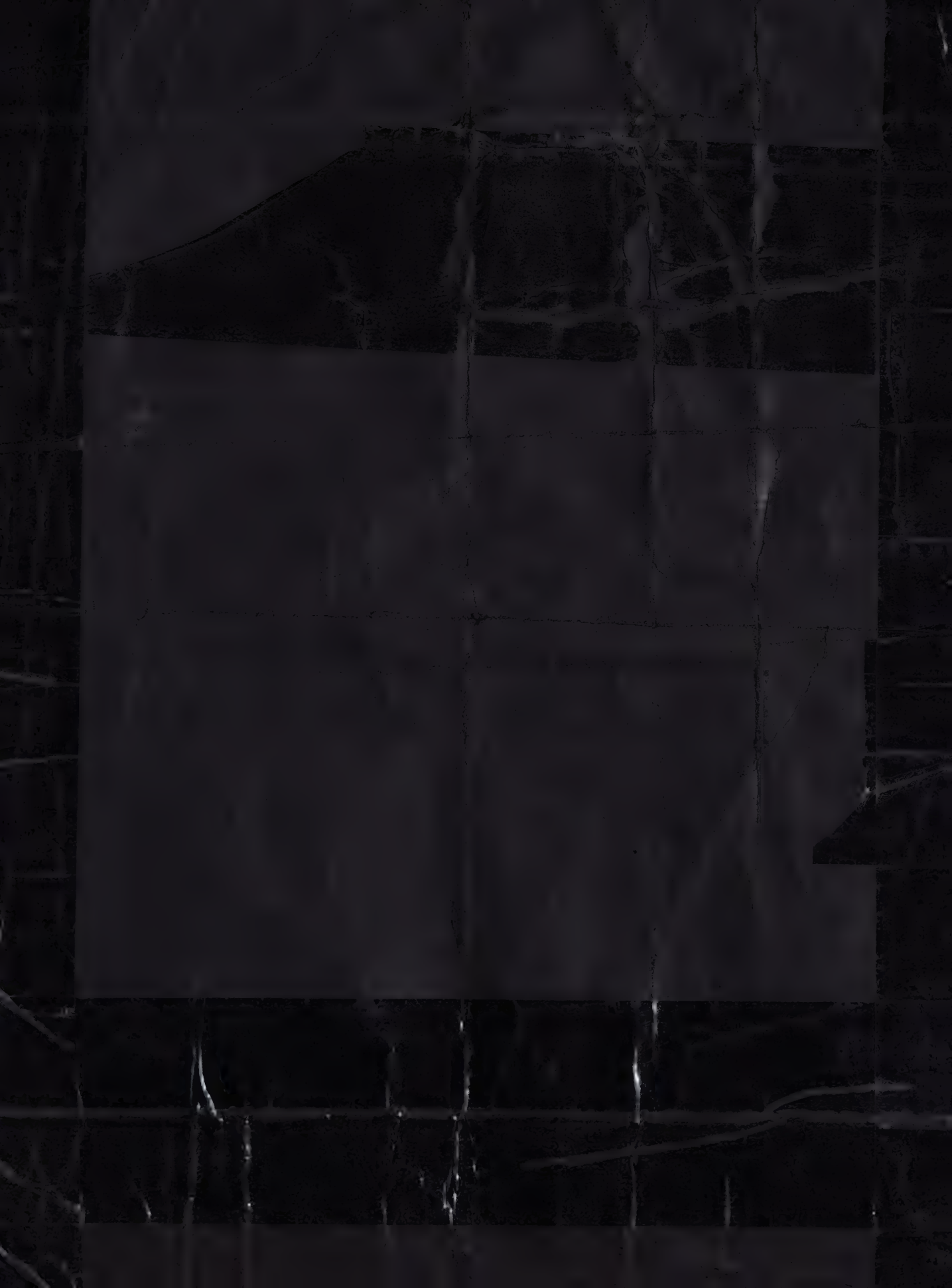
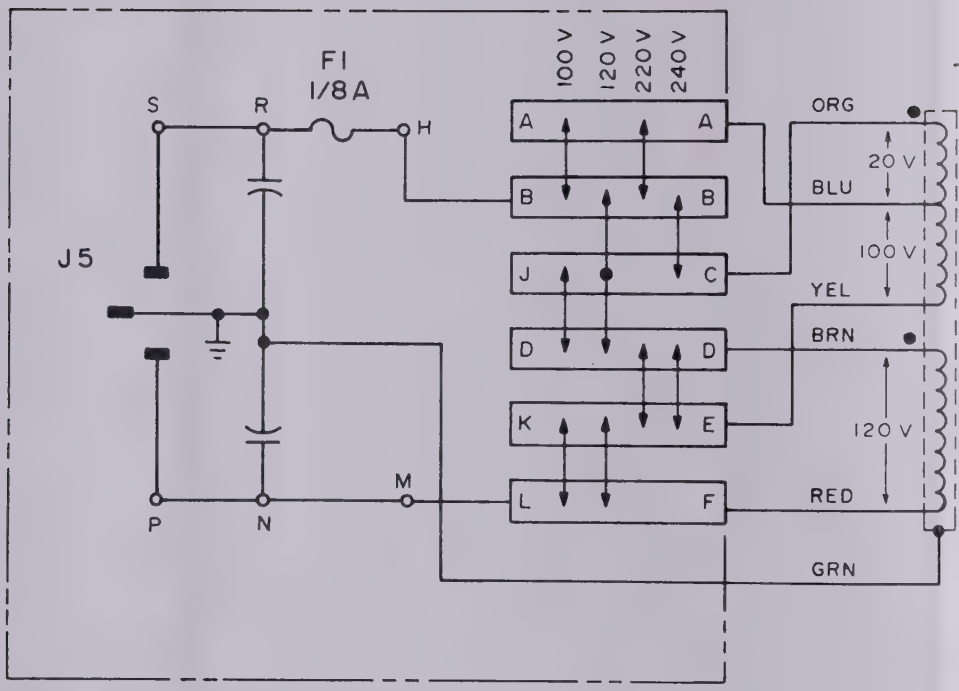
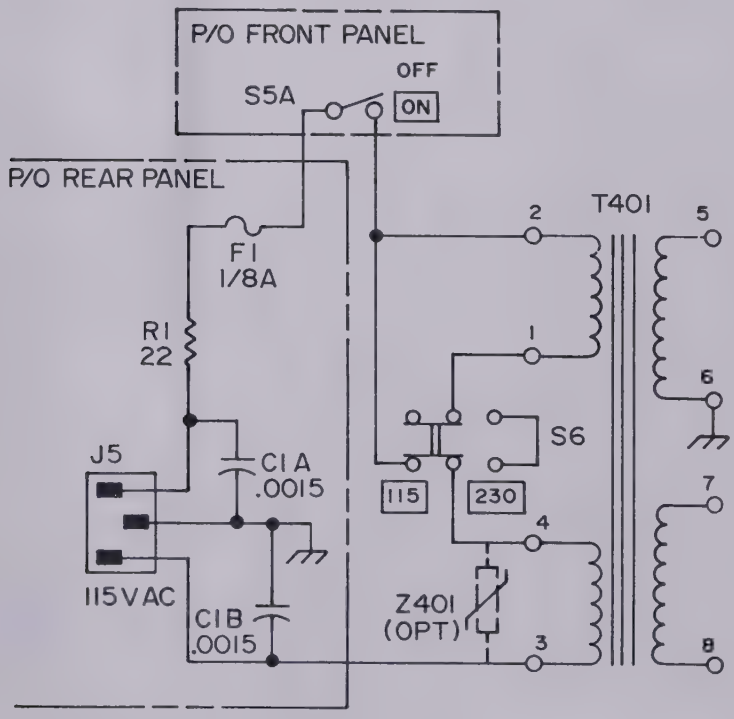


Figure 6-5. 3015A, AC Amplifier, Schematic Diagram





(FOR SERIAL NO. PREFIX 050-)



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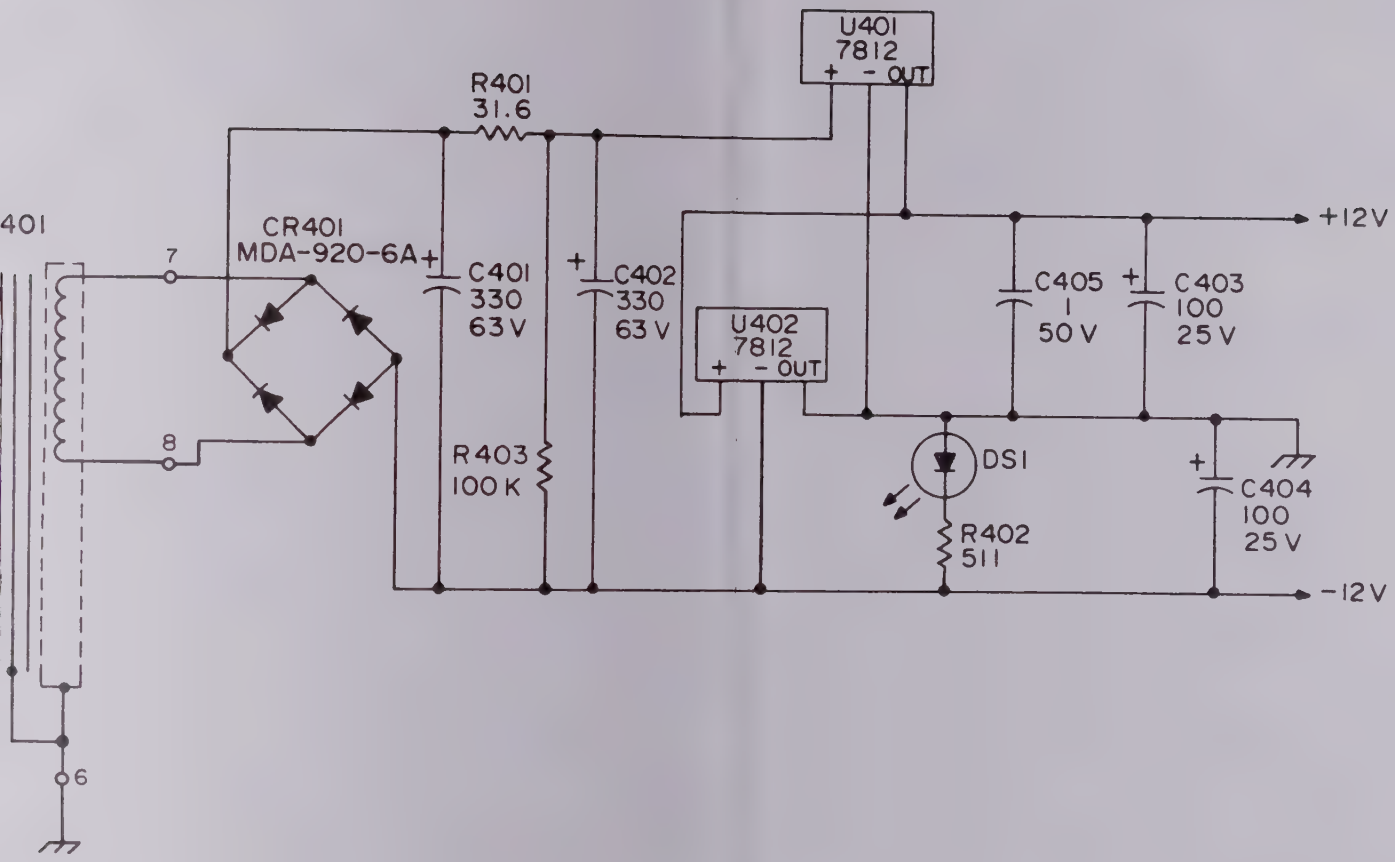
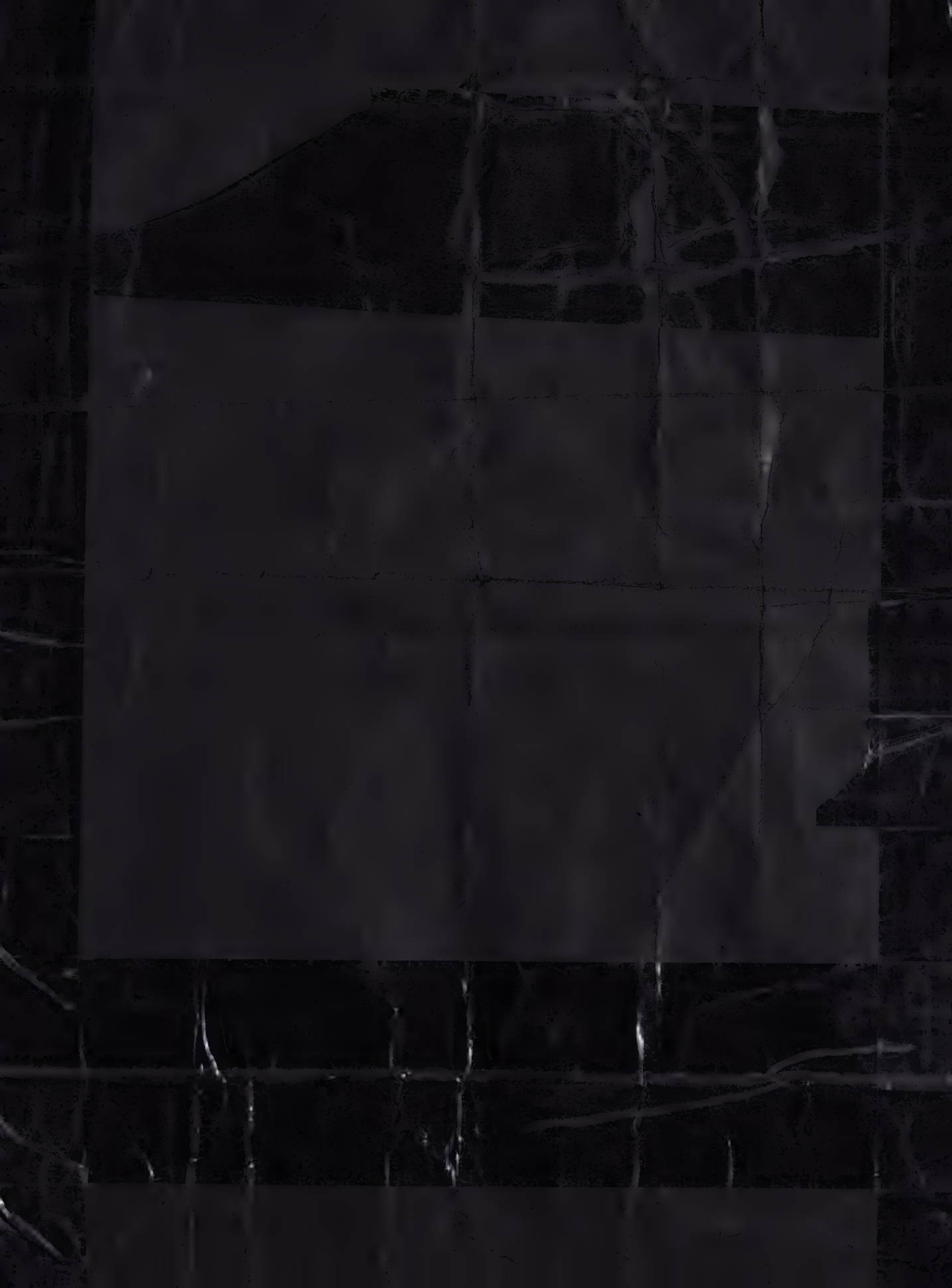


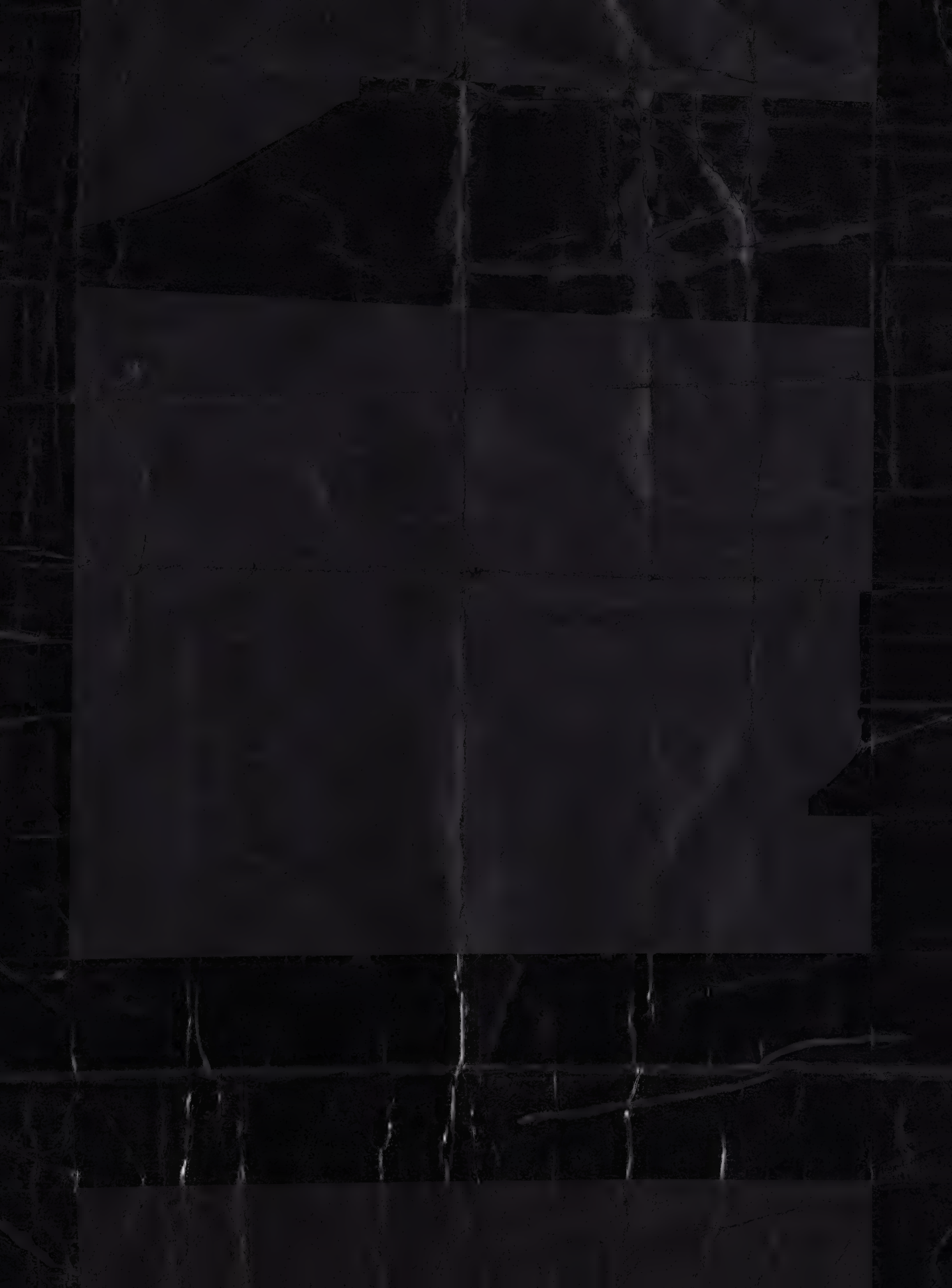
NOTE: ALL CAPACITOR VALUES ARE IN MICROFARADS AND ALL RESISTOR VALUES ARE IN OHMS.

Figure 6-6. 3015A, Power Supply, Schematic Diagram



Main P.C. Board (3015A MOD-92)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 101	07102500A	CYM 68.0NF 630.0 VK MET POL	80031	MEPCO C280MCG/A68K
C 103	07095740A	CCD 1.5 NF 1.0 KV +=10%	71590	CTL TYP DC-152
C 104	07101780A	CVP 10.0PF 750.0 VT 2-10PF	50423	JACKSON BROS. 5640/PM
C 105	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 106	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 107	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 108	07078330A	CEA1000 UF 16 V T	73445	AMPEREX C437AR/E1000
C 109	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 110	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 111	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	JACKSON BROS 5750
C 112	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C 113	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 114	07025080A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C 115	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	JACKSON BROS 5750
C 116	07095800A	CDD 100 PF J 5%	56289	SPG TYP 10TCC-T10
C 117	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 118	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 119	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 120	07102360A	CCD 3. NF 1. KVK	56289	SPRAGUE C016B102K302K
C 121	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 123	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 125	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C 126	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 127	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C 130	07102140A	CCD 47. NF 25. VM	56289	SPR C069B250J473M OR EQUV
C 131	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 132	07101970A	CCD 33.0PF 1.0KVJ NPO	56289	SPRAGUE C030B102G330J EQV
C 133	07102370A	CTF 100. MF 20.. VK	56289	SPRAGUE 196D107X9020MA3
C 134	07102380A	CTF 150.0UF 15.0VK	56289	SPRAGUE 196D157X9015MA3
C 141	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 142	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 143	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 202	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 203	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 205	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 206	07025080A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C 207	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 208	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C 209	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 210	07025080A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C 211	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 214	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 215	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 216	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 217	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 218	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 220	07101870A	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 1960335X0015
C 222	07102000A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 230D1B224K OR EQ
C 303	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 304	07100860A	CCD 68.0PF 500 V	90201	RMC TYPE CG
C 305	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 306	07081160A	CCT 15 PF 500 V J 5%	95121	QUALITY COMPONENTS
C 307	07022950A	CMD 82 PF V T	84171	ARCO DM-5-820
C 401	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 402	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 403	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 404	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 405	07101280A	CYM 1.0 UF 50.0V K	56289	SPRAGUE 431P1059R5
CR 201	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 202	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 401	05100530A	DGP 920A-6	04713	MOT



Main P.C. Board (3015A MOD-92) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
CR 402	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 403	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 404	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
Q 101	10100781A	TRQ 40673 SEL FOR IDS	50423	BLI SEL PER 99-100225A
Q 102	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 103	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 104	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 105	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 201	10100771A	TRQ 2N4121 PNP 1 40 PTO-18	50423	BLI 5 450M 150
Q 202	10100771A	TRQ 2N4121 PNP 1 40 PTO-18	50423	BLI 5 450M 150
Q 203	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 204	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 205	10080550A	TRQ 2N 918 PNP 1 15 PTO-18	07263	FCH .300 900M 20
Q 206	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 301	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 302	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
Q 303	10079410A	TRQ 2N4121 PNP 1 40 PTO-18	07263	FCH .500 450M 40
R 101	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 102	12088650A	RFF 10.0 M 500.0MW F+- 1%	03888	PYF TYP PME-70
R 103	12125000A	RFF 100.0 K 250.0MW FT- 1%	16299	CGW RN55D 1003 F
R 104	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 105	12123940A	RFF 9.53K 250.0MW FT- 1%	16299	CGW RN55D 9531 F
R 106	09100050A	RVF 1.00K 0.5 WK CERMET	73138	HELIPOT 72PM
R 107	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 108	12123440A	RFF 2.80K 250.0MW FT- 1%	16299	CGW RN55D 2871 F
R 109	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 110	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 111	12122500A	RFF 332.0 250.0MW FT- 1%	16299	CGW RN55D 3320 F
R 112	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 113	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 114	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 115	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 116	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 117	12122600A	RFF 422.0 250.0MW FT- 1%	16299	CGW RN55D 4220 F
R 118	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 119	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 120	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 121	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 122	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 123	12123040A	RFF 1.10K 250.0MW FT- 1%	16299	CGW RN55D 1101 F
R 124	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 126	12123720A	RFF 5.62K 250.0MW FT- 1%	16299	CGW RN55D 5621 F
R 127	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 128	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 129	12122480A	RFF 316.0 250.0MW FT- 1%	16299	CGW RN55D 3160 F
R 130	12123680A	RFF 5.11K 250.0MW FT- 1%	16299	CGW RN55D 5111 F
R 131	12123800A	RFF 6.81K 250.0MW FT- 1%	16299	CGW RN55D 6811 F
R 132	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 133	12122400A	RFF 261.0 250.0MW FT- 1%	16299	CGW RN55D 2610 F
R 134	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 135	12127720A	RFF 563.6 250.0MW A	03888	PYROFILM PME60T9 563.6
R 136	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 137	12127710A	RFF 481.2 250.0MW A	03888	PYROFILM PME60T9 481.2
R 138	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 139	12127690A	RFF 329.0 250.0MW A	03888	PYROFILM PME60T9 329.0
R 140	12122000A	RFF 100.0 250.0MW FT- 1%	16299	CGW RN55D 1000 F
R 141	12122280A	RFF 196.0 250.0MW FT- 1%	16299	CGW RN55D 1960 F
R 142	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 143	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 144	12128150A	RFC 6.8 125.0MW J+- 5%	01121	A-B TYPE BB
R 145	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 146*	12121000A	RFF 10.0 250.0MW FT- 1%	16299	CGW RN55D 10R0 F
R 146*	12126460A	RCF 5.05 125.0MW F+- 1%	00327	WELWYN 4333 GR00972
R 146*	12127930A	RFC 3.6 125.0MW	01121	A-B TYPE BB
R 146*	12128090A	RFC 2.7 125.0MW J+- 5%	01121	A-B TYPE BB
R 146*	12128150A	RFC 6.8 125.0MW J+- 5%	01121	A-B TYPE BB
R 147	12124520A	RFF 34.8 K 250.0MW FT- 1%	16299	CGW RN55D 3482 F
R 148	12123280A	RFF 1.91K 250.0MW FT- 1%	16299	CGW RN55D 1961 F
R 149	12122000A	RFF 100.0 250.0MW FT- 1%	16299	CGW RN55D 1000 F
R 150	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 160	12122800A	RFF 681.0 250.0MW FT- 1%	16299	CGW RN55D 6810 F
R 161	27100030A	THR 1.0 K 5% +5900PPM/C	16299	CGW TSR5 1001J
R 162	27011530A	THR-200 K+-10%	83186	VTF TYPE 2259
R 201	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 203	12123320A	RFF 2.10K 250.0MW FT- 1%	16299	CGW RN55D 2151 F
R 204	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F
R 205	12121320A	RFF 21.5 250.0MW FT- 1%	16299	CGW RN55D 21R5 F
R 206	12123400A	RFF 2.55K 250.0MW FT- 1%	16299	CGW RN55D 2611 F
R 207	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 208	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 209	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 210	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 211	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 212	12124280A	RFF 19.6 K 250.0MW FT- 1%	16299	CGW RN55D 1962 F
R 213	12123440A	RFF 2.80K 250.0MW FT- 1%	16299	CGW RN55D 2871 F
R 214	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 215	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 216	12123560A	RFF 3.83K 250.0MW FT- 1%	16299	CGW RN55D 3831 F
R 217	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 218	12122880A	RFF 825.0 250.0MW FT- 1%	16299	CGW RN55D 8250 F
R 219	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 220	12122560A	RFF 383.0 250.0MW FT- 1%	16299	CGW RN55D 3830 F
R 221	12123760A	RFF 6.19K 250.0MW FT- 1%	16299	CGW RN55D 6191 F
R 222	09100020A	RVC 5.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 223	12123680A	RFF 5.11K 250.0MW FT- 1%	16299	CGW RN55D 5111 F
R 224	12122560A	RFF 383.0 250.0MW FT- 1%	16299	CGW RN55D 3830 F
R 225	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 226	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 227	12122480A	RFF 316.0 250.0MW FT- 1%	16299	CGW RN55D 3160 F
R 228	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 230	12124400A	RFF 26.1 K 250.0MW FT- 1%	16299	CGW RN55D 2612 F
R 231	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 232	12122440A	RFF 287.0 250.0MW FT- 1%	16299	CGW RN55D 2870 F
R 233	12124400A	RFF 26.1 K 250.0MW FT- 1%	16299	CGW RN55D 2612 F
R 234	12123180A	RFF 1.54K 250.0MW FT- 1%	16299	CGW RN55D 1541 F
R 235	12123080A	RFF 1.21K 250.0MW FT- 1%	16299	CGW RN55D 1211 F
R 236	12124000A	RFF 10.0 K 250.0MW FT- 1%	16299	CGW RN55D 1002 F
R 237	12123880A	RFF 8.25K 250.0MW FT- 1%	16299	CGW RN55D 8251 F
R 240	12124520A	RFF 34.8 K 250.0MW FT- 1%	16299	CGW RN55D 3482 F
R 241†	09100930A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 243†	09100930A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 246	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 247†	09100940A	RVF 500.0 500.0MW KVERT MT	73138	HELIPOT 72XW 500
R 248	12122840A	RFF 750.0 250.0MW FT- 1%	16299	CGW RN55D 7500 F
R 250	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 251	12123480A	RFF 3.16K 250.0MW FT- 1%	16299	CGW RN55D 3161 F
R 252	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 253	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 254	12124560A	RFF 38.3 K 250.0MW FT- 1%	16299	CGW RN55D 3832 F
R 260	12123120A	RFF 1.33K 250.0MW FT- 1%	16299	CGW RN55D 1331 F

*Factory selected value.

†Optionally available as internal adjustments. Ballantine part number for either R241 or R243 is P/N 09101240A; for R247, use P/N 09101250A.

Main P.C. Board (3015A MOD-92) - Continued

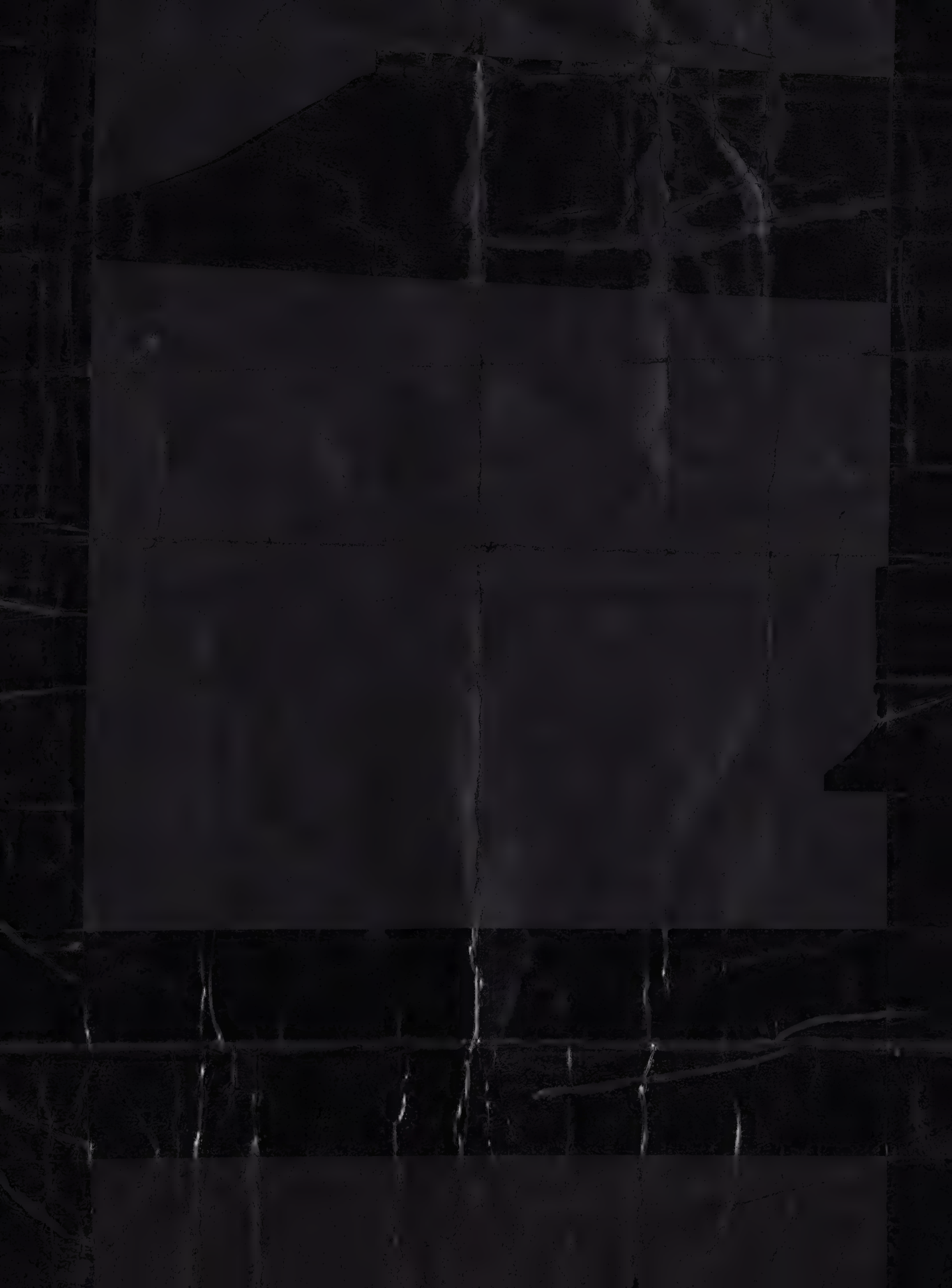
SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 261	27011560A	THR 10 K	83186	VTE TYPE 41D2
R 301	12123080A	RFF 1.21K 250.0MW FT- 1%	16299	CGW RN55D 1211 F
R 302	12121680A	RFF 51.1 250.0MW FT- 1%	16299	CGW RN55D 52R3 F
R 303	12122720A	RFF 562.0 250.0MW FT- 1%	16299	CGW RN55D 5620 F
R 304	12122160A	RFF 147.0 250.0MW FT- 1%	16299	CGW RN55D 1470 F
R 305	12122520A	RFF 348.0 250.0MW FT- 1%	16299	CGW RN55D 3480 F
R 306	12122600A	RFF 422.0 250.0MW FT- 1%	16299	CGW RN55D 4220 F
R 307	12122760A	RFF 619.0 250.0MW FT- 1%	16299	CGW RN55D 6190 F
R 310	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 311	12124280A	RFF 19.6 K 250.0MW FT- 1%	16299	CGW RN55D 1962 F
R 312	12123000A	RFF 1.0 K 250.0MW FT- 1%	16299	CGW RN55D 1001 F
R 313	12122160A	RFF 147.0 250.0MW FT- 1%	16299	CGW RN55D 1470 F
R 314	12121560A	RFF 38.3 250.0MW FT- 1%	16299	CGW RN55D 38R3 F
R 315	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 401	12121480A	F	16299	CGW RN55D 31R6 F
R 402	12122680A	RFF 511.0 250.0MW FT- 1%	16299	CGW RN55D 5110 F
R 403	12125000A	RFF 100.0 K 250.0MW FT- 1%	16299	CGW RN55D 1003 F
R 802*	12123160A	RFF 1.47K 250.0MW FT- 1%	16299	CGW RN55D 1471 F
R 802*	12123180A	RFF 1.54K 500MW FT-1%	16299	CGW RN55D 1541F
R 803*	13100161A	RNF 99.0 3015A-MOD 92	50423	BLI METER COMP.
S 5	25100750A	SWC TOG DPDT PC VERT NON THD	09353	C+K 7201 SY AV2 NON THD
S 6	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040
S 1A	25100781A	SWC PART OF 25100771A	50423	CTS
S 1B	25100531C	SWC SECT 1&2 OF 25-10055-1C	11236	CTS SER 212 12 P05
S 1C	25100791A	SWC PART OF 25100771A	50423	
S 1D	25100731A	SWC PART OF 25100551E	11236	CTS
S 1E	25100541B	SWC SECT 3&4 OF 25100551C	50423	CTS SER 212 12 POS
S 1F	25100581B	SWC SECT 5 OF 2510055-1C	50423	CTS SER 212 12 POS
T 401	20100020A	TRX DRIVER TRANSFORMER	50423	BRADLEY G713160
U 201	24094290A	ICP 8 LD MET CAN FCH MA741C	07263	FCHLD U5B7741312
U 401	24100510A	ICP 12 VOLT REG 1/2 A	07263	FCHLD 78M12C
U 402	24100510A	ICP 12 VOLT REG 1/2 A	07263	FCHLD 78M12C
Z 401	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10

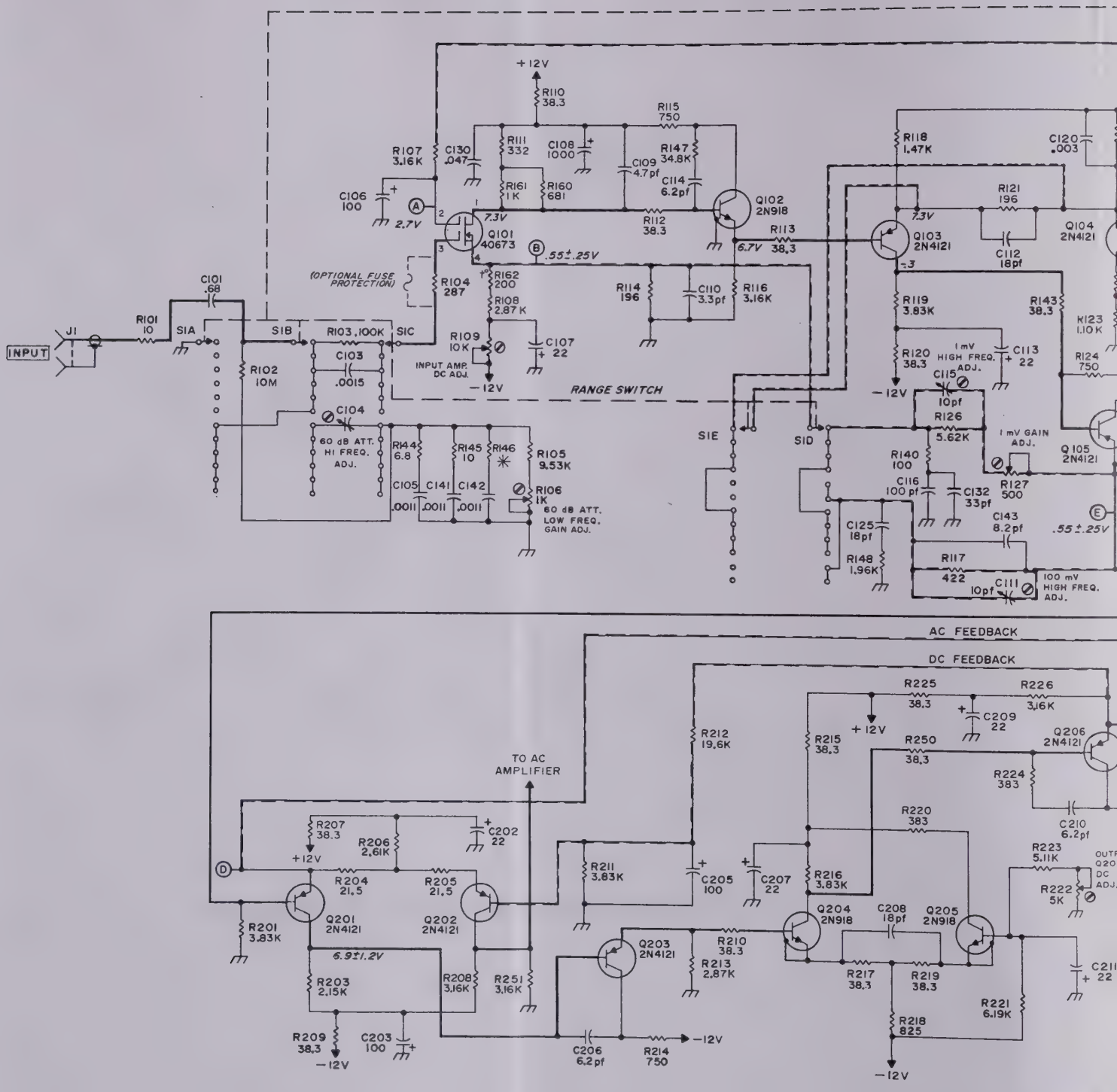
*When P/N 18-10026-1F is used for M201, R802 is 1.47k ohms and R803 is a temperature-compensating resistor network. When P/N 18-10037-1F is used for M201, R803 is not used--a short is used instead.

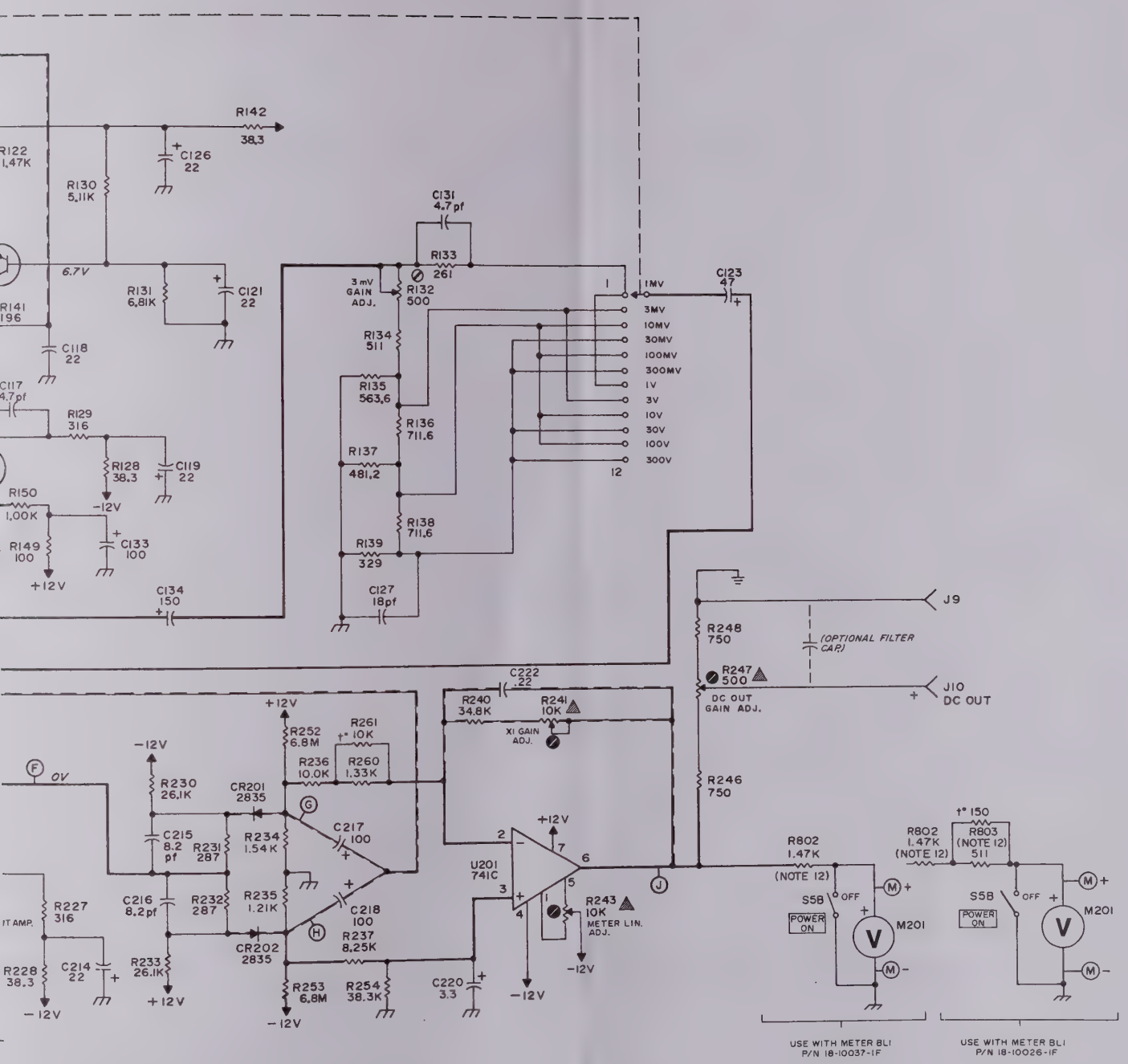
Front Panel (3015A MOD-92)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	16100000A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5082-4440
J 1	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
M 201*	18100261F	MTR 3045A 1MA 470 OHM 2%	50423	MODTC 4.51N SIL DAMP LIN
M 201*	18100371F	MTR 3045A 1 MA 470 OHM 2% TC	50423	MODUTEC 4.5 IN SEL DMP

*Replace with same part number.




+12V
R110 38.3
R115 750
R107 3.16K
C130 .047
R111 332
C108 1000
R147 34.8K
C109 4.7pf
C114 6.2pf
R161 1K
R160 681
C106 100
2.7V
7.3V
Q101 40673
Q102 2N918
R112 38.3
6.7V
R113 38.3
.55±.25V
(OPTIONAL FUSE PROTECTION)
R104 287
R162 200
R108 2.87K
R114 196
C110 3.3pf
R116 3.16K
C101 .68
R101 10
J1
INPUT
SIA
SIB
R103 100K
SIC
R109 10K
INPUT AMP. DC ADJ.
C107 22
−12V
RANGE SWITCH
R102 10M
C103 .0015
C104
60 dB ATT. HI FREQ. ADJ.
R144 6.8
R145 10
R146 ✳
R105 9.53K
C105 .0011
C141 .0011
C142 .0011
R106 1K
60 dB ATT. LOW FREQ. GAIN ADJ.
SIE
SID
R118 1.47K
C120 .003
R121 196
Q103 2N4121
Q104 2N4121
C112 18pf
R119 3.83K
R143 38.3
R123 1.10K
R120 38.3
1mV HIGH FREQ. ADJ.
C113 22
C115
10pf
R126 5.62K
R124 750
1mV GAIN ADJ.
Q105 2N4121
R140 100
C116 100 pf
C132 33pf
R127 500
C125 18pf
C143 8.2pf
.55±.25V
R148 1.96K
R117 422
C111 10pf
100 mV HIGH FREQ. ADJ.
AC FEEDBACK
DC FEEDBACK
R225 38.3
R226 3.16K
C209 22
R212 19.6K
R215 38.3
+12V
R250 38.3
Q206 2N4121
R224 383
C210 6.2pf
TO AC AMPLIFIER
R220 383
R207 38.3
R206 2.61K
C202 22
R223 5.11K
OUTP Q20 DC ADJ.
R222 5K
+12V
R204 21.5
R205 21.5
R211 3.83K
C205 100
C207 22
R216 3.83K
Q201 2N4121
Q202 2N4121
Q204 2N918
C208 18pf
Q205 2N918
R201 3.83K
6.9±1.2V
Q203 2N4121
R210 38.3
R213 2.87K
R217 38.3
R219 38.3
R203 2.15K
R208 3.16K
R251 3.16K
R221 6.19K
R218 825
R209 38.3
C203 100
−12V
C206 6.2pf
R214 750
−12V
−12V



NOTES:

1. CAPACITANCE IN µF UNLESS OTHERWISE NOTED.
2. RESISTANCE IN OHMS.
3. ALL VOLTAGES SHOWN IN ITALICS (*7.4V*) ARE MEASURED WITH A BATTERY POWERED DMM SUCH AS THE BALLANTINE 3/24. INPUT LEADS TO THE DMM ARE BUFFERED BY 10KΩ AT THE TIP OF EACH TEST LEAD. 3015A VM CONTROLS ARE AS SHOWN. INPUT CONNECTOR J1 IS SHORTED. ALL VOLTAGES ARE (±20%) VALUES, OR AS SHOWN.
4. ⊘ DENOTES INTERNAL ADJUSTMENT.
5. ⊘ DENOTES EXTERNALLY ACCESSIBLE ADJUSTMENT.
6. ——— DENOTES MAIN SIGNAL PATH.
7. ——— DENOTES FEEDBACK PATH.
8. ○ DENOTES TEST POINT.
9. □ DENOTES FRONT PANEL CONTROL.
10. ✳ DENOTES FACTORY SELECTED VALUE.
11. ⧋ THESE POTENTIOMETERS ARE AVAILABLE AS INTERNAL ADJUSTMENT OPTIONS.
12. t°∿∿ DENOTES TEMPERATURE SENSITIVE RESISTOR. WITH METER P/N 18-10026-1F, R802 IS 1.47KΩ AND R803 IS A TEMPERATURE-COMPENSATING RESISTOR NETWORK. WITH METER P/N 18-10037-1F, R803 IS REPLACED BY A SHORTING STRAP. ALWAYS REPLACE M201 WITH 18-10037-1F.

Figure 6-7. 3015A MOD-92, Schematic Diagram

NOTE: AC AMPLIFIER CIRCUIT LOCATED ON MAIN BOARD ASSEMBLY

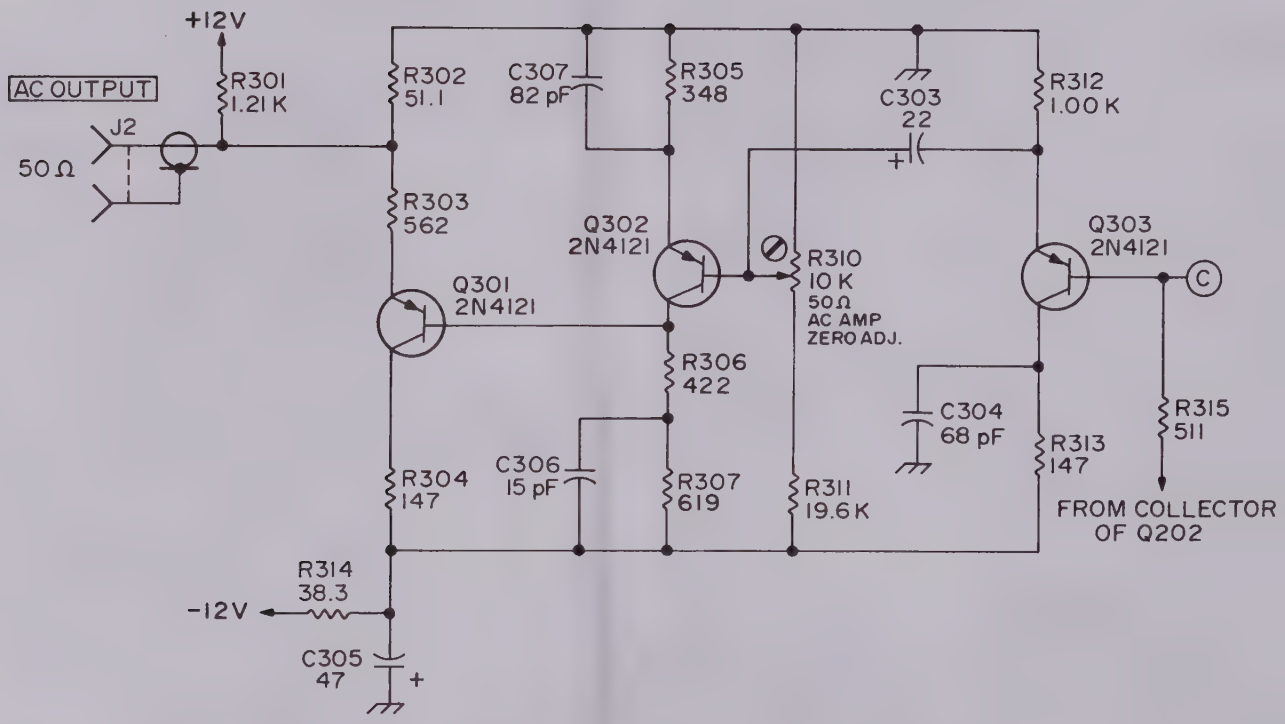
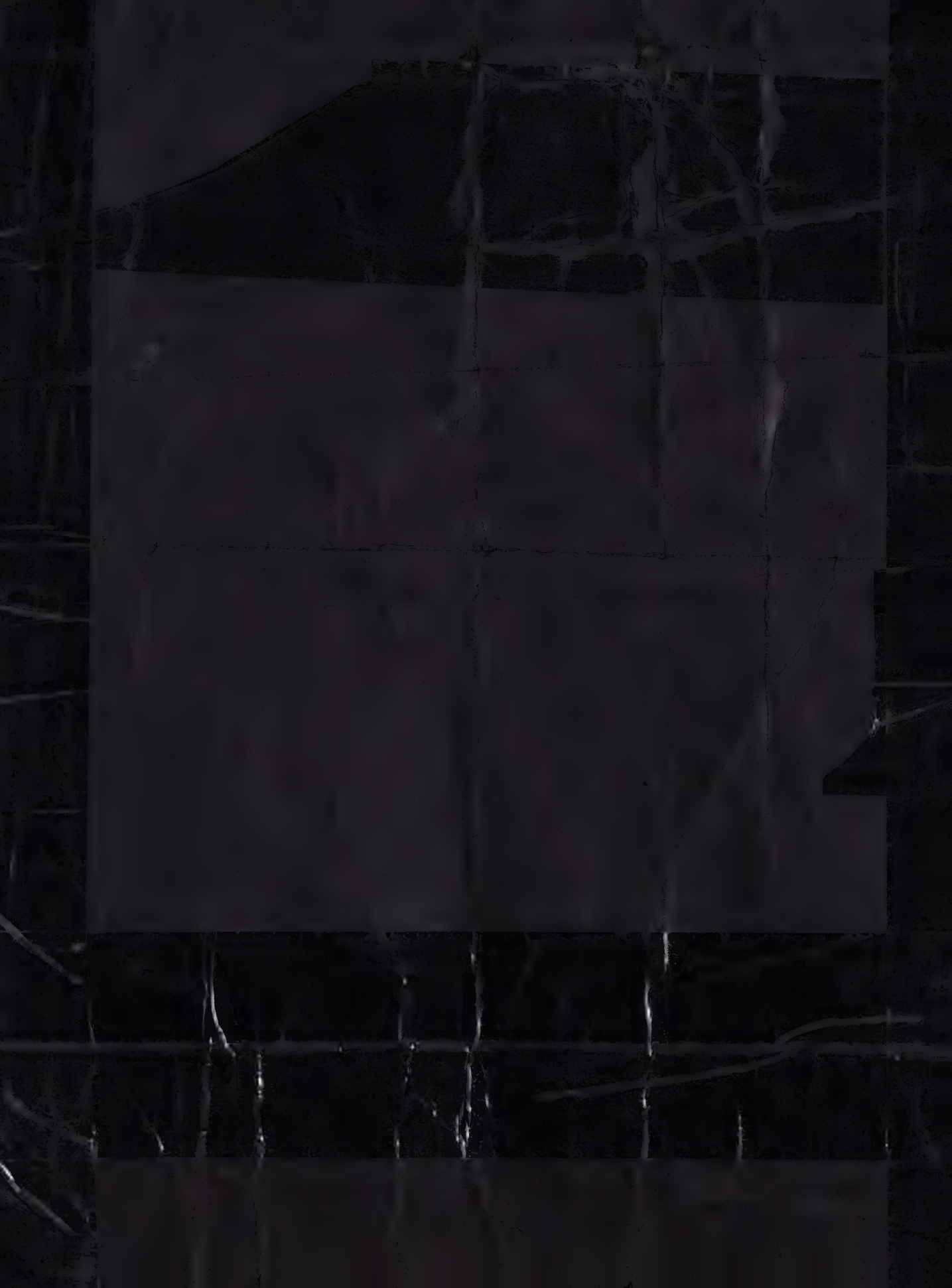
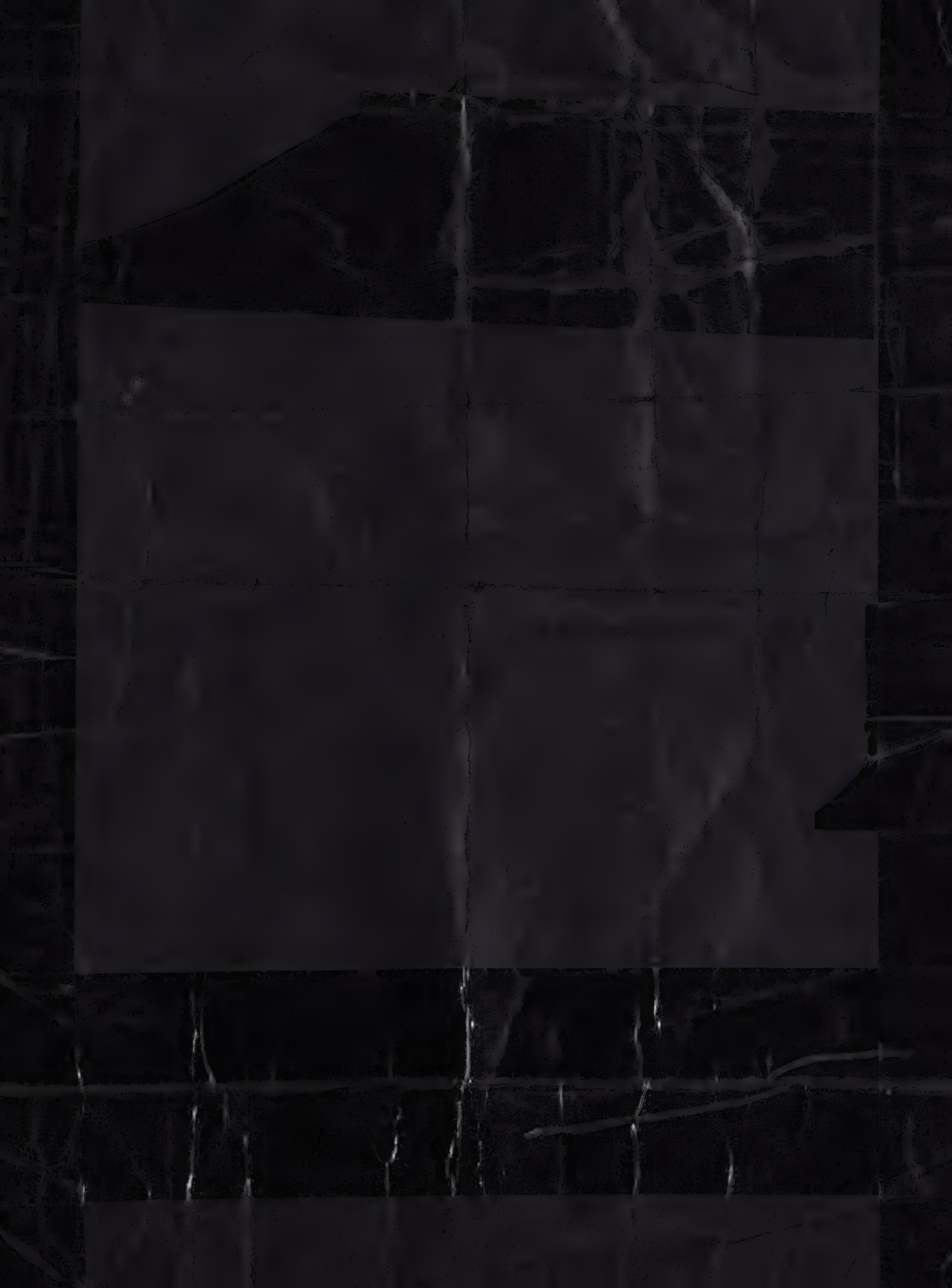
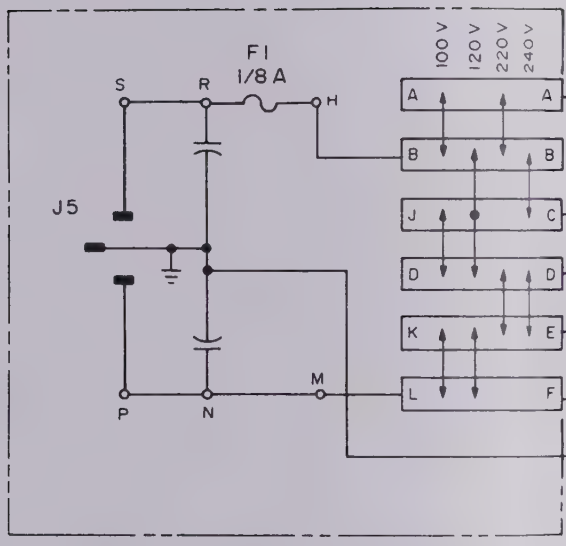


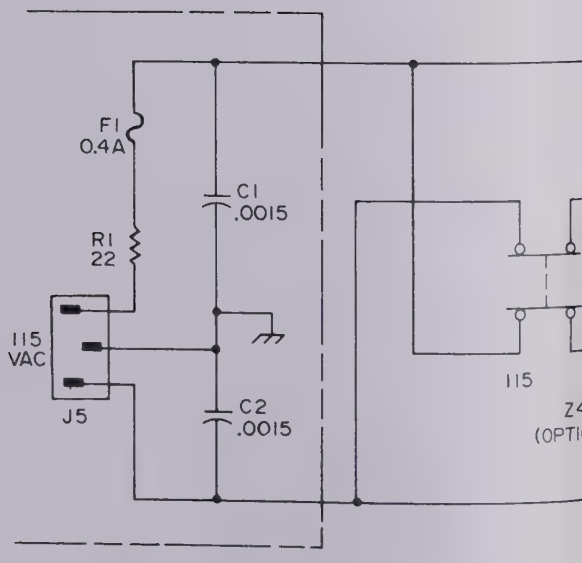
Figure 6-8. 3015A MOD-92, AC Amplifier, Schematic Diagram



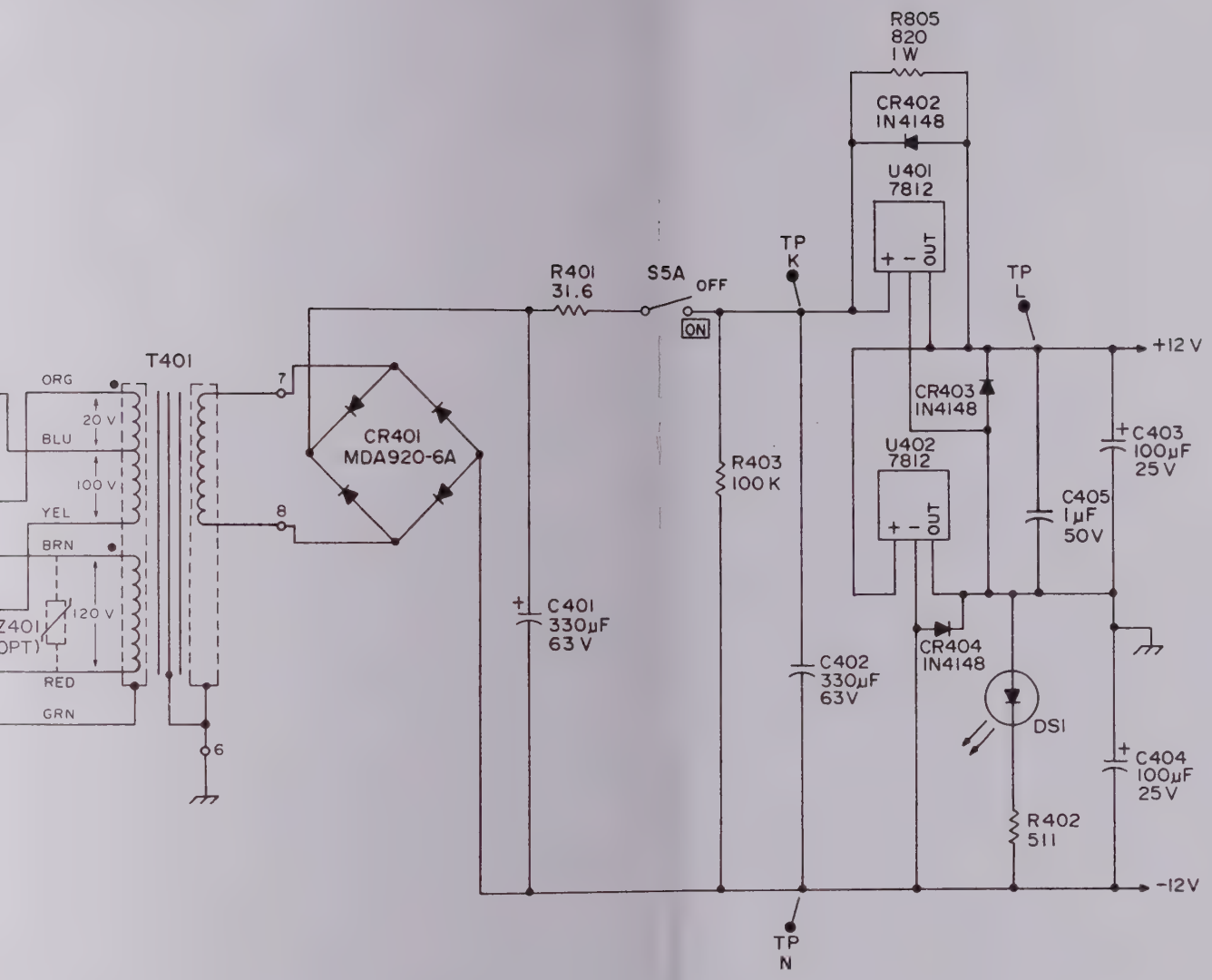


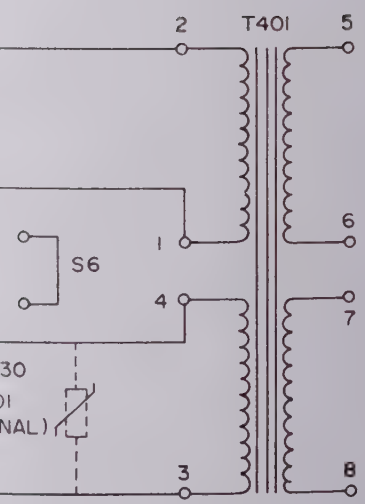


(FOR SERIAL NO. PREFIX 050- AND ABOVE)



(FOR SERIAL NO. PREFIX 020-)

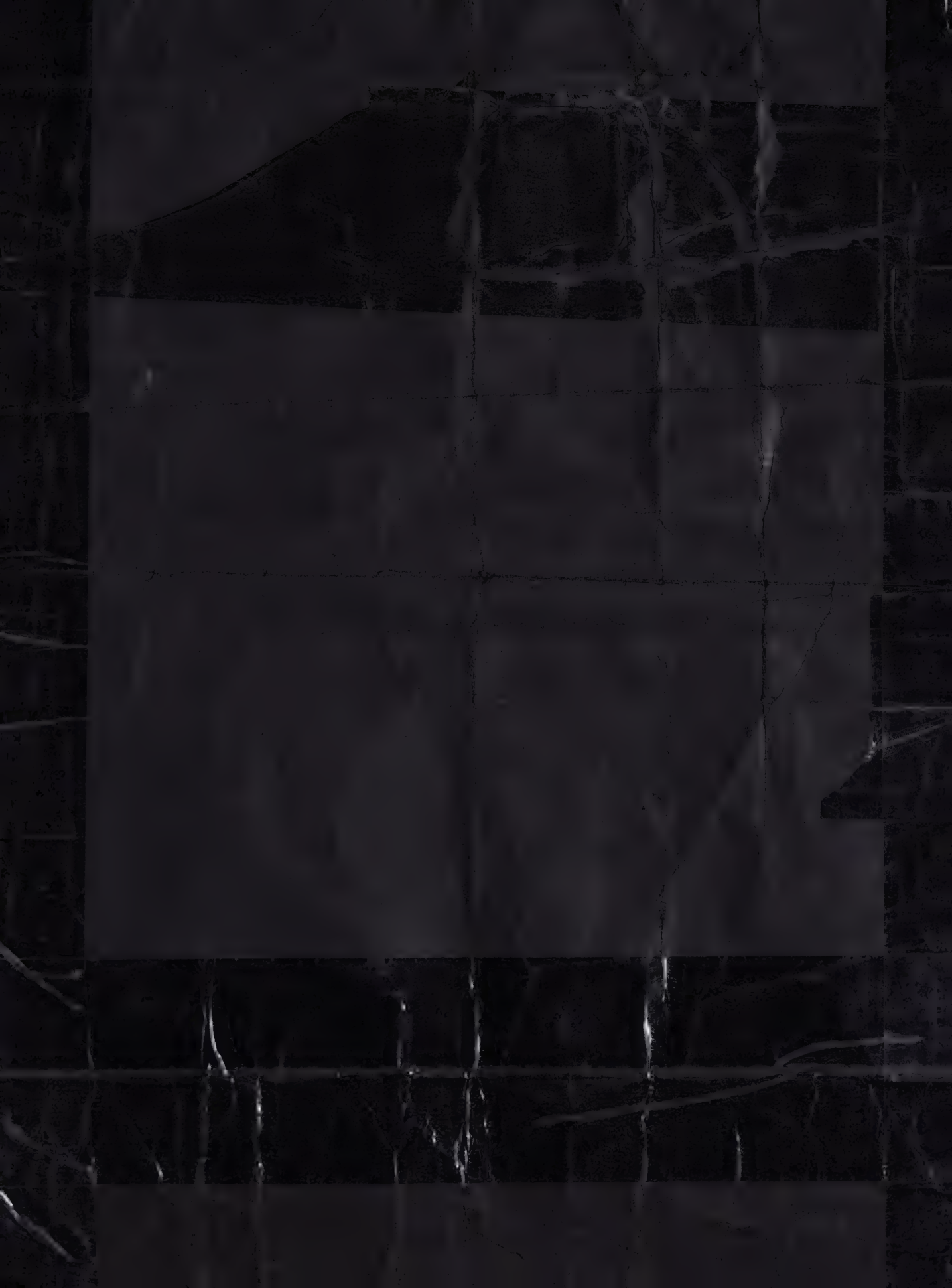


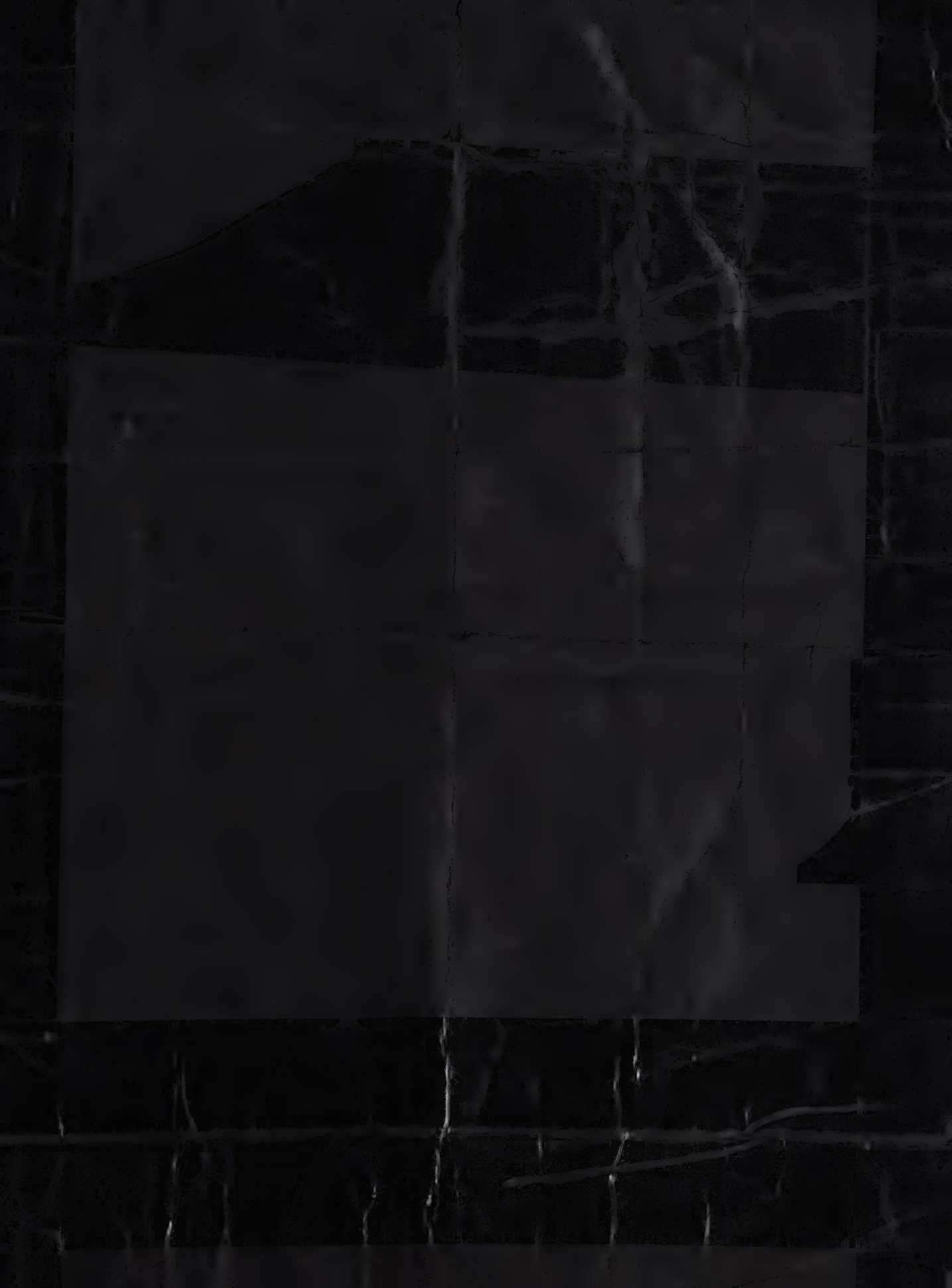


NOTES:

1. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL RESISTOR VALUES ARE IN OHMS.

Figure 6-9. 3015A MOD-92, Power Supply, Schematic Diagram





SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C101	07-10250-0A	CYM 68.0NF 630.0 VK MET POL	80031	MEPCO C280MCG/A68K
C103	07-09574-0A	CCD 1.5NF 1.0KV +-10%	71590	CTL TYP DD-152
C104	07-10178-0A	CVP 10.0PF 750.0 VT 2-10PF	50423	
C105	07-10215-0A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C106	07-10184-0A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C107	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C108	07-07833-0A	CEA1000.0UF 16.0 VT	73445	AMPEREX C437AR/E1000
C109	07-10006-0A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C110	07-10081-0A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C112	07-10180-0A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C113	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C114	07-02508-0A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C115	07-10181-0A	CVP 10.0PF 750.0 V 2-10PF	50423	
C116	07-09580-0A	CDD 100 PF J 5%	56289	SPG TYP 10TCC-T10
C117	07-10006-0A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C118	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C119	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C120	07-10236-0A	CCD 3. NF 1. KVK	56289	SPRAGUE C016B102K302K
C121	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C123	07-10183-0A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C125	07-10180-0A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C126	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C127	07-10180-0A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C000B102F180J
C130	07-10214-0A	CCD 47. NF 25. VM	56289	SPR C069B250J473M OR EQUV
C131	07-10006-0A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C132	07-10197-0A	CCD 33.0PF 1.0KVJ NPO	56289	SPRAGUE C030B102G330J EQV
C133	07-10237-0A	CTF 100.0UF 20.0 VK	56289	SPRAGUE 196D107X9020MA3
C134	07-10238-0A	CTF 150.0UF 15.0VK	56289	SPRAGUE 196D157X9015MA3
C135	07-20003-0A	CCD 47.0PF 500.0 VK +-10%	71590	CTL DD-470
C141	07-10215-0A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C142	07-10215-0A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C143	07-10186-0A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C202	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C203	07-10237-0A	CTF 100.0UF 20.0 VK	56289	SPRAGUE 196D107X9020MA3
C205	07-10184-0A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C206	07-02508-0A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C207	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C209	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C210	07-02508-0A	CCT 6.2PF J+- 5%	95121	QUALITY COMPONENTS
C211	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C214	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C215	07-10186-0A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C216	07-10186-0A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C217	07-10184-0A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C218	07-10184-0A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C220	07-10187-0A	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 1960335X0015
C222	07-10200-0A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 230D1B224K OR EQ
C303	07-10179-0A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C304	07-10186-0A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C305	07-10183-0A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C306	07-08116-0A	CCT 15 PF 500 V J 5%	95121	QUALITY COMPONENTS
C307	07-02295-0A	CMD 82 PF V T	84171	ARCO DM-5-820
C401	07-10252-0A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREC ET331X063AD3
C402	07-10252-0A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREC ET331X063AD3
C403	07-10235-0A	CEA 100.0UF 25.0 VT	73445	AMPREX ET101X025A5
C404	07-10235-0A	CEA 100.0UF 25.0 VT	73445	AMPREX ET101X025A5
C405	07-10126-0A	CEA 100. UF 3. VT	56289	SPRAGUE 30D107G003C80
CR201	05-10021-0A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR202	05-10021-0A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR501	05-07920-0A	DGP 1N4148 75 10M	7263	FCH SI D035
CR502	05-07920-0A	DGP 1N4148 75 10M	7263	FCH SI D035
CR503	05-07920-0A	DGP 1N4148 75 10M	7263	FCH SI D035

PARTS LIST (3015A MOD-95) - Continued

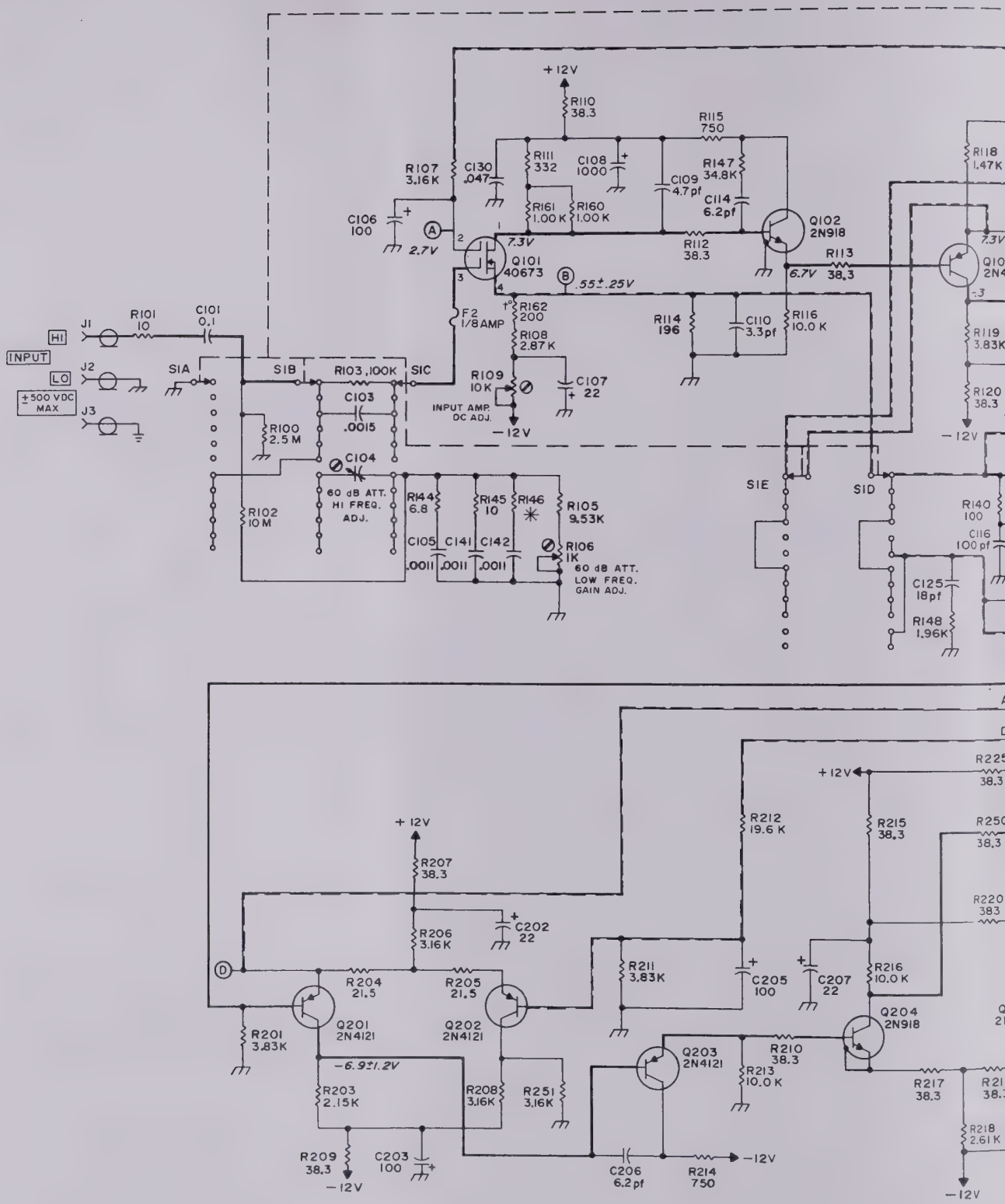
SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
ICP201	24-09429-0A	ICP 8 LD MET CAN FCHD MA741C	7263	FCHLD 0587741312
Q101	10-10078-1A	TRQ 40673 SEL FOR IDS	50423	
Q102	10-08055-0A	TRQ 2N918 PNP 1 15 PTO-18	7263	FCH .300 900M 20
Q103	10-07941-0A	TRQ 2N4121 PNP 1 40 PTO-18	7263	FCH .500 450M 40
Q104	10-07941-0A	TRQ 2N4121 PNP 1 40 PTO-18	7263	FCH .500 450M 40
Q105	10-07941-0A	TRQ 2N4121 PNP 1 40 PTO-18	7263	FCH .500 450M 40
Q201	10-10077-1A	TRQ 2N4121 PNP 1 40 PTO-18	50423	
Q202	10-10077-1A	TRQ 2N4121 PNP 1 40 PTO-18	50423	
Q203	10-07941-0A	TRQ 2N4121 PNP 1 40 PTO-18	7263	FCH .500 450M 40
Q204	10-08055-0A	TRQ 2N918 PNP 1 15 PTO-18	7263	FCH .300 900M 20
Q205	10-08055-0A	TRQ 2N918 PNP 1 15 PTO-18	7263	FCH .300 900M 20
Q206	10-07941-0A	TRQ 2N4121 PNP 1 40 PTO-18	7263	FCH .500 450M 40
Q501	10-10004-0A	TRQ MJE520 NPN 1 30 P77-03	4713	MOT 25 25
R100	12-13113-0A	2.5 M 1.0 W F	3888	PYR PME70 T-0
R101	12-12100-0A	RFF 10.0 250.0MW F+- 1%	16299	CGW RN55D 10R0 F
R102	12-08865-0A	RFF 10.0 M 500.0MW F +- 1%	3888	PYF TYP PME-70
R103	12-12500-0A	RFF 100.0 K 250.0MW F+- 1%	16299	CGW RN55D 1003 F
R104	12-12244-0A	RFF 287.0 250 MW F+-1%	16299	CGW RN55D 2870 F
R105	12-12394-0A	RFF 9.53K 250.0MW F+- 1%	16299	CGW RN55D 9531 F
R106	09-10005-0A	RVF 1.0 K 0.5 W K CERMET	73138	HELIPOT 72PM
R107	12-12348-0A	RFF 3.16K 250.0MW F+- 1%	16299	CGW RN55D 3161 F
R108	12-12344-0A	2.87K	16299	CGW RN55D 2871 F
R109	09-10008-0A	RVF 10.0 K 0.5 W K+-10%	73138	HEL TYP 72PM
R110	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R111	12-12250-0A	RFF 332.0 250 MW F+-1%	16299	CGW RN55D 3320 F
R112	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R113	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R114	12-12228-0A	RFF 196.0 250 MW F+-1%	16299	CGW RN55D 1960 F
R115	12-12284-0A	RFF 750.0 250 MW F+-1%	16299	CGW RN55D 7500 F
R116	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R117	12-12260-0A	RFF 422.0 250 MW F+-1%	16299	CGW RN55D 4220 F
R118	12-12316-0A	RFF 1.47K 250 MW F+-1%	16299	CGW RN55D 1471 F
R119	12-12356-0A	RFF 3.83K 250.0MW F+- 1%	16299	CGW RN55D 3831 F
R120	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R121	12-12228-0A	RFF 196.0 250 MW F+-1%	16299	CGW RN55D 1960 F
R122	12-12316-0A	RFF 1.47K 250 MW F+-1%	16299	CGW RN55D 1471 F
R123	12-12304-0A	RFF 1.10K 250 MW F+-1%	16299	CGW RN55D 1101 F
R124	12-12284-0A	RFF 750.0 250 MW F+-1%	16299	CGW RN55D 7500 F
R126	12-12372-0A	RFF 5.62K 250.0MW F+- 1%	16299	CGW RN55D 5621 F
R127	09-10001-0A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R128	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R129	12-12248-0A	RFF 316.0 250 MW F+-1%	16299	CGW RN55D 3160 F
R130	12-12368-0A	RFF 5.11K 250.0MW F+- 1%	16299	CGW RN55D 5111 F
R131	12-12380-0A	RFF 6.81K 250.0MW F+- 1%	16299	CGW RN55D 6811 F
R132	09-10001-0A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R133	12-12240-0A	RFF 261.0 250 MW F+-1%	16299	CGW RN55D 2610 F
R134	12-12268-0A	RFF 511.0 250 MW F+-1%	16299	CGW RN55D 5110 F
R135	12-12772-0A	RFF 563.6 250.0MW A	3888	PYROFILM PME60T9 563.6
R136	12-12770-0A	RFF 711.6 250.0MW A	3888	PYROFILM PME60T9 711.0
R137	12-12771-0A	RFF 481.2 250.0MW A	3888	PYROFILM PME60T9 481.2
R138	12-12770-0A	RFF 711.6 250.0MW A	3888	PYROFILM PME60T9 711.0
R139	12-12769-0A	RFF 329.0 250.0MW A	3888	PYROFILM PME60T9 329.0
R140	12-12200-0A	RFF 100.0 250.0MW F+- 1%	16299	CGW RN55D 1000 F
R141	12-12228-0A	RFF 196.0 250 MW F+-1%	16299	CGW RN55D 1960 F
R142	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R143	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R144	12-12815-0A	RFC 6.8 125.0MW J+- 5%	1121	A-B TYPE BB
R145	12-12100-0A	RFF 10.0 250.0MW F+- 1%	16299	CGW RN55D 10R0 F
R146	12-12815-0A	RFC 6.8 125.0MW J+- 5%	1121	A-B TYPE BB
R147	12-12452-0A	RFF 34.8 K 250.0MW F+- 1%	16299	CGW RN55D 3482 F
R148	12-12328-0A	RFF 1.96K 250.0MW F+- 1%	16299	CGW RN55D 1961 F

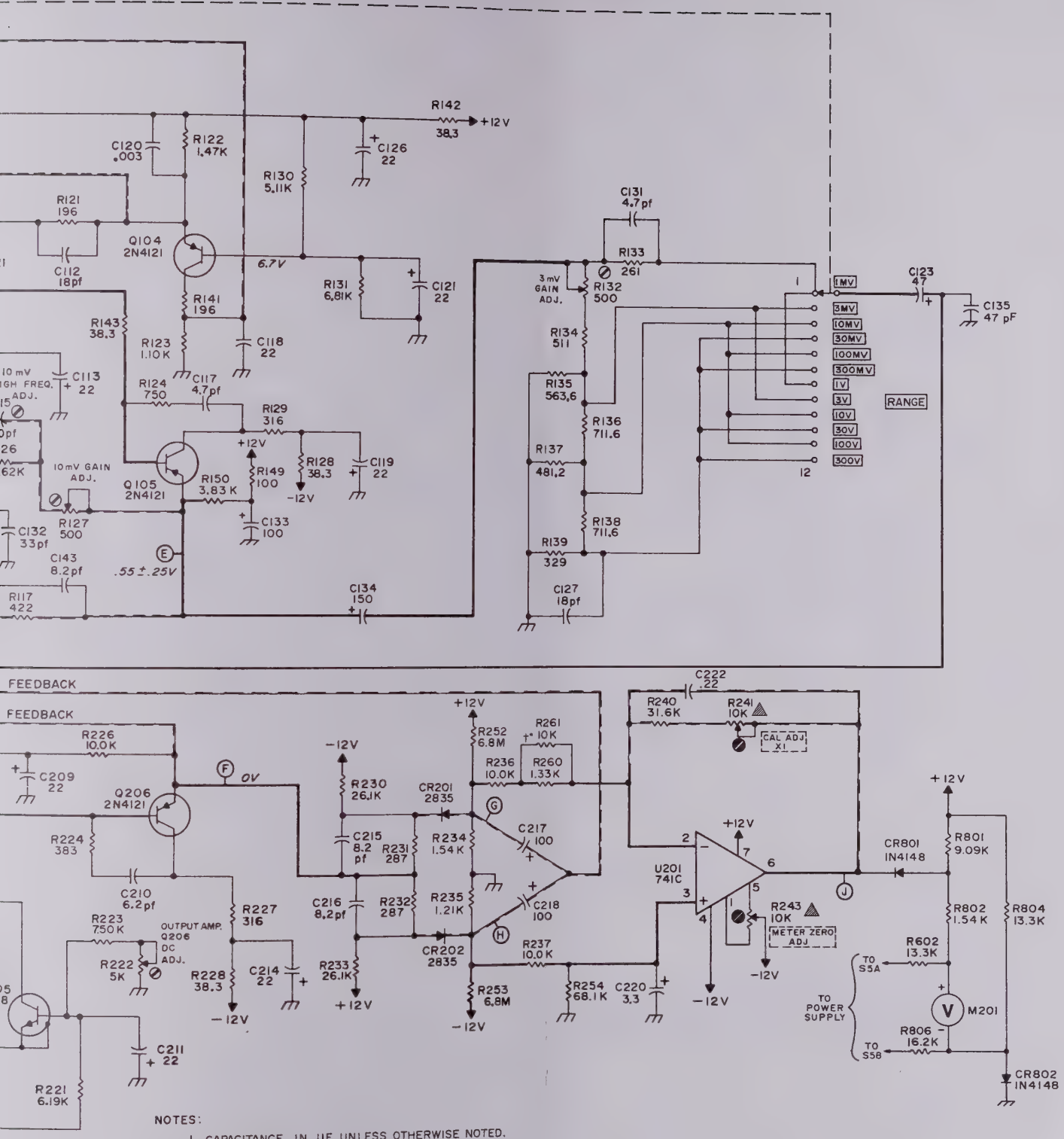
PARTS LIST (3015A MOD-95) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R149	12-12200-0A	RFF 100.0 250.0MW F+- 1%	16299	CGW RN55D 1000 F
R150	12-12356-0A	RFF 3.83K 250.0MW F+- 1%	16299	CGW RN55D 3831 F
R160	12-12280-0A	RFF 681.0 250 MW F+-1%	16299	CGW RN55D 6810 F
R161	12-12300-0A	RFF 1.0 K 250 MW F+-1%	16299	CGW RN55D 1001 F
R162	27-01153-0A	THR-200 K+-10%	83186	VTE TYPE 22E9
R201	12-12356-0A	RFF 3.83K 250.0MW F+- 1%	16299	CGW RN55D 3831 F
R203	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R204	12-12132-0A	RFF 21.5 250.0MW F+- 1%	16299	CGW RN55D 21R5 F
R205	12-12132-0A	RFF 21.5 250.0MW F+- 1%	16299	CGW RN55D 21R5 F
R206	12-12408-0A	RFF 12.1 K 250.0MW F+- 1%	16299	CGW RN55D 1212 F
R207	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R208	12-12348-0A	RFF 3.16K 250.0MW F+- 1%	16299	CGW RN55D 3161 F
R209	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R210	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R211	12-12356-0A	RFF 3.83K 250.0MW F+- 1%	16299	CGW RN55D 3831 F
R212	12-12428-0A	RFF 19.6 K 250.0MW F+- 1%	16299	CGW RN55D 1962 F
R213	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R214	12-12284-0A	RFF 750.0 250 MW F+-1%	16299	CGW RN55D 7500 F
R215	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R216	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R217	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R218	12-12340-0A	RFF 2.61K 250.0MW F+- 1%	16299	CGW RN55D 2611 F
R219	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R220	12-12256-0A	RFF 383.0 250 MW F+-1%	16299	CGW RN55D 3830 F
R221	12-12376-0A	RFF 6.19K 250.0MW F+- 1%	16299	CGW RN55D 6191 F
R222	09-10002-0A	RVC 5.0 K 0.5 W K+-10%	73138	HEL TYP 72PM
R223	12-12368-0A	RFF 5.11K 250.0MW F+- 1%	16299	CGW RN55D 5111 F
R224	12-12256-0A	RFF 383.0 250 MW F+-1%	16299	CGW RN55D 3830 F
R225	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R226	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R227	12-12248-0A	RFF 316.0 250 MW F+-1%	16299	CGW RN55D 3160 F
R228	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R230	12-12440-0A	RFF 26.1 K 250.0MW F+- 1%	16299	CGW RN55D 2612 F
R231	12-12244-0A	RFF 287.0 250 MW F+-1%	16299	CGW RN55D 2870 F
R232	12-12244-0A	RFF 287.0 250 MW F+-1%	16299	CGW RN55D 2870 F
R233	12-12440-0A	RFF 26.1 K 250.0MW F+- 1%	16299	CGW RN55D 2612 F
R234	12-12318-0A	RFF 1.54K 250 MW F+-1%	16299	CGW RN55D 1541 F
R235	12-12308-0A	RFF 1.21K 250 MW F+-1%	16299	CGW RN55D 1211 F
R237	12-12400-0A	RFF 10.0 K 250.0MW F+- 1%	16299	CGW RN55D 1002 F
R240	12-12472-0A	RFF 56.2 K 250.0MW F+- 1%	16299	CGW RN55D 5622 F
R241	09-10093-0A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R243	09-10093-0A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R250	12-12156-0A	RFF 38.3 250.0MW F+- 1%	16299	CGW RN55D 38R3 F
R251	12-12348-0A	RFF 3.16K 250.0MW F+- 1%	16299	CGW RN55D 3161 F
R252	12-01002-0A	RFC 6.8 M 500.0MW K+-10%	1121	A-B TYP EB
R253	12-01002-0A	RFC 6.8 M 500.0MW K+-10%	1121	A-B TYP EB
R254	12-12480-0A	RFF 68.1 K 250.0MW F+- 1%	16299	CGW RN55D 6812 F
R260	12-12312-0A	RFF 1.33K 250 MW F+-1%	16299	CGW RN55D 1331 F
R261	27-01156-0A	THR 10 K	83186	VTE TYPE 41D2
R401	12-12120-0A	RFF 16.2 250.0MW F+- 1%	16299	CGW RN55D 16R2 F
R402	12-12792-0A	RFC 910.0 1.0 W J+- 5%	1121	A-B TYPE GB
R403	12-12500-0A	RFF 100.0 K 250.0MW F+- 1%	16299	CGW RN55D 1003 F
R403	12-12792-0A	RFC 910.0 1.0 W J+- 5%	1121	A-B TYPE GB
R501	12-12420-0A	RFF 16.2 K 250.0MW F+- 1%	16299	CGW RN55D 1622 F
R802	12-12316-0A	RFF 1.47K 250 MW F+-1%	16299	CGW RN55D 1471 F
R805	12-12448-0A	RFF 31.6 K 250.0MW F+- 1%	16299	CGW RN55D 3162 F
S1A	25-10078-1A	SWC PART OF 25100771A	50423	
S1B	25-10053-1C	SWC SECT 1&2 OF 25-10055-1C	11236	CTS SER 212 12 P05
S1C	25-10079-1A	SWC PART OF 25100771A	50423	
S1D	25-10073-1A	SWC PART OF 25100551E	11236	CTS
S1E	25-10054-1B	SWC SECT 3&4 OF 25100551C	50423	

PARTS LIST (3015A MOD-95) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
S1F	25-10058-1B	SWC SECT 5 OF 2510055-1C	50423	
S5	25-10171-0A	SWC DPDT TOGGLE 3POS 1 MOM	9353	C&K SW7207 KDZRED ANOD CP
T401	20-10013-1N	TRX 3045A SERIES POWER BLI	50423	
∠401	14-10000-0A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10


+12V
R110 38.3
R115 750
R111 332
C108 1000
R107 3.16K
C130 .047
R147 34.8K
C109 4.7pf
C114 6.2pf
R161 1.00K
R160 1.00K
C106 100
2.7V
7.3V
Q101 40673
Q102 2N918
R112 38.3
6.7V
R113 38.3
55±.25V
R118 1.47K
R119 3.83K
R120 38.3
F2 1/8AMP
R162 200
R108 2.87K
R114 196
C110 3.3pf
R116 10.0K
J1
HI
INPUT
J2
LO
±500 VDC MAX
J3
R101 10
C101 0.1
SIA
SIB
R103, 100K
SIC
R109 10K
INPUT AMP. DC ADJ.
C107 22
−12V
C103 .0015
R100 2.5 M
C104
60 dB ATT. HI FREQ. ADJ.
R102 10 M
R144 6.8
R145 10
R146
R105 9.53K
C105 .0011
C141 .0011
C142 .0011
R106 1K
60 dB ATT. LOW FREQ. GAIN ADJ.
SIE
SID
R140 100
C116 100 pf
C125 18pf
R148 1.96K
R207 38.3
R206 3.16K
C202 22
R204 21.5
R205 21.5
R201 3.83K
Q201 2N4121
Q202 2N4121
−6.9±1.2V
R203 2.15K
R208 3.16K
R251 3.16K
R209 38.3
C203 100
R211 3.83K
R212 19.6 K
C205 100
C207 22
R215 38.3
R216 10.0 K
Q204 2N918
Q203 2N4121
R210 38.3
R213 10.0 K
R217 38.3
R218 2.61K
C206 6.2pf
R214 750



NOTES:

1. CAPACITANCE IN μF UNLESS OTHERWISE NOTED.
2. RESISTANCE IN OHMS.
3. ALL VOLTAGES SHOWN IN ITALICS (*7.4V*) ARE MEASURED WITH A BATTERY POWERED DMM SUCH AS THE BALLANTINE 3028A. INPUT LEADS TO THE DMM ARE BUFFERED BY 10KΩ AT THE TIP OF EACH TEST LEAD. 3015A VM CONTROLS ARE AS SHOWN. INPUT CONNECTOR J1 IS SHORTED. ALL VOLTAGES ARE (±20%) VALUES, OR AS SHOWN.
4. ⊘ DENOTES INTERNAL ADJUSTMENT.
5. ⊘ DENOTES EXTERNALLY ACCESSIBLE ADJUSTMENT.
6. ——— DENOTES MAIN SIGNAL PATH.
7. ——— DENOTES FEEDBACK PATH.
8. ○ DENOTES TEST POINT.
9. □ DENOTES FRONT PANEL CONTROL.
10. [ ] DENOTES REAR PANEL CONTROL.
11. △ THESE POTENTIOMETERS ARE AVAILABLE AS INTERNAL ADJUSTMENT OPTIONS.
12. t°~~ DENOTES TEMPERATURE SENSITIVE RESISTOR.
13. ✳ DENOTES FACTORY SELECTED VALUE.

Figure 6-10. 3015A — MOD 95, Schematic Diagram.

SECTION 7
MANUAL BACKDATING CHANGES

Applicable to 3045A and 3046A, Serial No. Prefix 020- thru 023-

Main P.C. Board (3045A and 3046A, Serial No. Prefix 020- thru 023-)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 101	C71C2500A	CYM 68.0NF 630.0 VK MET POL	80031	MEPCO C280MCG/A68K
C 102	79C54730A	CBL FXR	29587	AMPHENOL #214-079
C 103	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
C 104	C71C178CA	CVP 10.0PF 750.0 VT 2-10PF	50423	
C 105	07102150A	CMM 1.1NF 500. VJ	84171	ARCO CM2CE112J CR EQUIV.
C 106	C71C184CA	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 107	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 108	07078330A	CEA1000 UF 16 V T	73445	AMPEREX C437AR/E1000
C 109	C71CC060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 110	C71C081CA	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 111	C71C181CA	CVP 10.0PF 750.0 V 2-10PF	50423	
C 112	C71C18C0A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CCCCB102F180J
C 113	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 114	C71C185CA	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 115	C71C181CA	CVP 10.0PF 750.0 V 2-10PF	50423	
C 116	07095800A	CCD 100 PF J 5%	56289	SPG TYP 101CC-110
C 117	C71CCC60A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 118	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 119	C7101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 120	C71C236CA	CCD 3. NF 1. KVK	56289	SPRAGUE C0168102K302K
C 121	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 122	071C243CA	CCD 6.8NF 250.0 VK	56289	SPRAGUE C067A251J682K
C 123	C71C183CA	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 125	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CCCCB1C2F18CJ
C 126	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 127	071C180CA	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CCCCB102F180J
C 130	07102140A	CCD 47. NF 25. VM	56289	SPR CC65B25CJ473M OR EQUV
C 131	C71CCC60A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 132	07101970A	CCD 33.0PF 1.0KVJ NPO	56289	SPRAGUE CC3CB1C2G330J EQV
C 133	071C237CA	CTF 100. MF 20. VK	14674	CORNING TK4C2C1C7-1C
C 134	C71C238CA	CTF 150. MF 10. VK	14674	CORNING TC5010157-10
C 141	07102150A	CMM 1.1NF 500. VJ SILV MI	84171	ARCO CM20E112J CR EQUIV.
C 142	07102150A	CMM 1.1NF 500. VJ SILV MI	84171	ARCO CM2CE112J CR EQUIV.
C 143	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 202	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 203	C71C237CA	CTF 100. MF 20. VK	14674	CORNING TK4020107-10
C 205	C7101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 206	C71C185CA	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 207	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 208	C7101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE CCCCB1C2F18CJ
C 209	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 210	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 211	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 214	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 215	C7101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 216	C71C186CA	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 217	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 218	C7101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 220	C71C187CA	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 196D335X0015
C 222	07102000A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 23CD1B224K OR EQ
C 301	C71C179CA	CTF 47. UF 35. V	50423	
C 303	C71C179CA	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 304	C7100860A	CCD 68.0PF 500 V	90201	RMC TYPE CG
C 305	C71C183CA	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 306	07081160A	CCT 15 PF 500 V J 5%	95121	QUALITY COMPONENTS
C 307	07101990A	CCD 27.0PF 1.0KVJ NPO	56289	SPRAG CC3CB102C27CJ OR EQ
C 308	07102440A	CET 330.0UF 6.00VK	56289	SPRAGUE 196D337X906 MA3
C 401	07102520A	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 402	C71C252CA	CEA 330.0UF 63.0 V -10+50%	73445	AMPEREX ET331X063AD3
C 403	071C235CA	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 404	C7102350A	CEA 100. MF 25. VT	73445	AMPREX ET1C1XC25A5
C 405	C7101280A	CYM 1. UF 100. VT	99515	MARSHALL D1-105 OR EQUIV
CR 101	05C79200A	DGP 1N4148 GE OR	07263	FAIRCHILD,FCH 6C0
CR 102	C5C79200A	DGP 1N4148 GE OR	07263	FAIRCHILD,FCH 6C0
CR 201	C51CC210A	DGP SCHOTTKY .34V FWD 5VRVS	28480	HP 5082-2835 LOW OFF-SET
CR 202	05100210A	DGP SCHOTTKY .34V FWD 5VRVS	28480	HP 5082-2835 LOW OFF-SET
CR 203	C51CC210A	DGP SCHOTTKY .34V FWD 5VRVS	28480	HP 5082-2835 LOW OFF-SET
CR 401	C51CC530A	DGP BRIDGE RECT. MDA52C-6A	C4713	MICIRCLA
CR 505	05080580A	DGP 1N4006	15328	ITT

Main P.C. Board (3045A and 3046A, Serial No. Prefix 020- thru 023-) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
CR 506	05080580A	DGP 1N4006	15328	ITT
CR 801	C5C79200A	DGP 1N4148 GE OR	C7263	FAIRCHILD,FDH 6CC
CR 802	C5C7S2CCA	DGP 1N4148 GE CR	07263	FAIRCHILD,FDH 600
ICP 201	24094290A	ICP 8 LD MET CAN FCHD MA741C	C7263	FCHLD L5B7741312
ICP 401	2410C510A	ICP 12 VCLT REG 78M12C 1/2A	07263	FAIRCHILD 78M12C OR EQUIV
ICP 402	241CC510A	ICP 12 VCLT REG 78M12C 1/2A	07263	FAIRCHILD 78M12C OR EQUIV
Q 101	10100580A	TRQ RCA 40673 OVAL GATE MOS	66684	RCA N CHAN DEPL TO 400MHZ
Q 102	1CC8C550A	TRC 2N918	07263	FAIRCHILD
Q 103	1CC7941CA	TRQ 2N4121	C7263	FAIRCHILD
Q 104	10C79410A	TRC 2N4121	C7263	FAIRCHILD
Q 105	10C79410A	TRQ 2N4121	C7263	FAIRCHILD
Q 201	1CC7941CA	TRQ 2N4121	07263	FAIRCHILD
Q 202	10C79410A	TRQ 2N4121	C7263	FAIRCHILD
Q 203	1CC79410A	TRC 2N4121	C7263	FAIRCHILD
Q 204	1CC8C55CA	TRC 2N918	07263	FAIRCHILD
Q 205	10080550A	TRQ 2N918	C7263	FAIRCHILD
Q 206	1CC7941CA	TRC 2N4121	07263	FAIRCHILD
Q 301	1CC7941CA	TRQ 2N4121	07263	FAIRCHILD
Q 302	1CC79410A	TRQ 2N4121	C7263	FAIRCHILD
Q 303	1CC7941CA	TRC 2N4121	07263	FAIRCHILD
R 101	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW NA 60
R 102	12C8865CA	RFF 1C.C M 5CC MW F+- 1%	03888	PYF TYP PME-7C
R 103	12125000A	RFF 1CC.C K 5CC MW F+-1%	16299	CGW NA 6C
R 104	1212244CA	RFF 287.C 500 MW F+-1%	16299	CGW NA 6C
R 105	1212394CA	RFF 9.53K 500 MW F+-1%	16299	CGW NA 60
R 106	CS100050A	RVF 1.00K 0.5 WK CERMET	73138	HELIPOT 72PM
R 107	1212348CA	RFF 3.16K 500 MW F+-1%	16299	CGW NA 60
R 108	12123440A	RFF 2.87K 5CC MW F+-1%	16299	CGW NA 60
R 109	CS1C0080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 110	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 60
R 111	12122880A	RFF 825.C 5CC MW F+-1%	16299	CGW NA 6C
R 112	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 113	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 60
R 114	12122280A	RFF 196.0 500 MW F+-1%	16299	CGW NA 6C
R 115	12122840A	RFF 750.C 500 MW F+-1%	16299	CGW NA 60
R 116	12123480A	RFF 3.16K 5CC MW F+-1%	16299	CGW NA 60
R 117	12122600A	RFF 422.C 5CC MW F+-1%	16299	CGW NA 60
R 118	12123160A	RFF 1.47K 5CC MW F+-1%	16299	CGW NA 60
R 119	12123560A	RFF 3.83K 5CC MW F+-1%	16299	CGW NA 6C
R 120	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 6C
R 121	1212228CA	RFF 196.C 5CC MW F+-1%	16299	CGW NA 60
R 122	12123160A	RFF 1.47K 500 MW F+-1%	16299	CGW NA 6C
R 123	12123C40A	RFF 1.10K 500 MW F+-1%	16299	CGW NA 60
R 124	12122840A	RFF 750.C 5CC MW F+-1%	16299	CGW NA 60
R 126	12123720A	RFF 5.62K 500 MW F+-1%	16299	CGW NA 60
R 127	CS1CCC10A	RVC 5CC.C 0.5 WK +-10%	73138	HEL TYP 72PM
R 128	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 6C
R 129	1212248CA	RFF 316.0 500 MW F+-1%	16299	CGW NA 60
R 130	1212368CA	RFF 5.11K 5CC MW F+-1%	16299	CGW NA 60
R 131	12123800A	RFF 6.81K 500 MW F+-1%	16299	CGW NA 6C
R 132	CS1CC010A	RVC 500.C 0.5 WK +-10%	73138	HEL TYP 72PM
R 133	12122400A	RFF 261.C 5CC MW F+-1%	16299	CGW NA 60
R 134	12122680A	RFF 511.C 500 MW F+-1%	16299	CGW NA 6C
R 135	12127720A	RFF 563.6 250.0MWA	C3888	PYROFILM PME6CTS 563.6
R 136	12127700A	RFF 711.6 250.0MWA	03888	PYROFILM PME6CTS 711.C
R 137	12127710A	RFF 481.2 250.CMWA	C3888	PYROFILM PME6CTS 481.2
R 138	12127700A	RFF 711.6 250.0MWA	03888	PYROFILM PME6CTS 711.C
R 139	1212769CA	RFF 329.C 250.CMWA	03888	PYROFILM PME6CTS 329.C
R 140	12122000A	RFF 1CC.C 5CC MW F+-1%	16299	CGW NA 6C
R 141	12122280A	RFF 196.0 500 MW F+-1%	16299	CGW NA 6C
R 142	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 60
R 143	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 6C
R 144	1212F150A	RFC 6.8 125.0MWJ	01121	A-B TYPE BB
R 145	12121000A	RFF 1C.C 5CC MW F+-1%	16299	CGW NA 60
R 146	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW NA 60
R 147	12124520A	RFF 34.8 K 5CC MW F+-1%	16299	CGW NA 60
R 148	12123280A	RFF 1.96K 5CC MW F+-1%	16299	CGW NA 6C
R 149	12122C00A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 150	12123C00A	RFF 1.0 K 5CC MW F+-1%	16299	CGW NA 60

Main P.C. Board (3045A and 3046A, Serial No. Prefix 020- thru 023-) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 151	12123880A	RFF 8.25K 5C0 MW F+-1%	16299	CGW NA 60
R 201	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW NA 60
R 203	12123320A	RFF 2.15K 5CC MW F+-1%	16299	CGW NA 60
R 204	12121320A	RFF 21.5 5C0 MW F+-1%	16299	CGW NA 60
R 205	12121320A	RFF 21.5 5CC MW F+-1%	16299	CGW NA 60
R 206	12123400A	RFF 2.61K 5CC MW F+-1%	16299	CGW NA 60
R 207	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 208	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW NA 60
R 209	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 210	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 211	12123560A	RFF 3.83K 5CC MW F+-1%	16299	CGW NA 60
R 212	12124280A	RFF 19.6 K 500 MW F+-1%	16299	CGW NA 60
R 213	12123440A	RFF 2.87K 5CC MW F+-1%	16299	CGW NA 60
R 214	12122840A	RFF 75C.C 5CC MW F+-1%	16299	CGW NA 60
R 215	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 216	12123560A	RFF 3.83K 5CC MW F+-1%	16299	CGW NA 60
R 217	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 218	12122880A	RFF 825.0 500 MW F+-1%	16299	CGW NA 60
R 219	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 60
R 220	12122560A	RFF 383.0 500 MW F+-1%	16299	CGW NA 60
R 221	12123760A	RFF 6.19K 5C0 MW F+-1%	16299	CGW NA 60
R 222	09100020A	RVC 5.C K C.5 WK +-1C%	73138	HEL TYP 72PM
R 223	12123680A	RFF 5.11K 500 MW F+-1%	16299	CGW NA 60
R 224	12122560A	RFF 383.0 5CC MW F+-1%	16299	CGW NA 60
R 225	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 226	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW NA 60
R 227	12122480A	RFF 316.C 5CC MW F+-1%	16299	CGW NA 60
R 228	12121560A	RFF 38.3 5C0 MW F+-1%	16299	CGW NA 60
R 230	12124400A	RFF 26.1 K 5CC MW F+-1%	16299	CGW NA 60
R 231	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW NA 60
R 232	12122440A	RFF 287.C 5CC MW F+-1%	16299	CGW NA 60
R 233	12124400A	RFF 26.1 K 5C0 MW F+-1%	16299	CGW NA 60
R 234	12123180A	RFF 1.54K 500 MW F+-1%	16299	CGW NA 60
R 235	12123080A	RFF 1.21K 5CC MW F+-1%	16299	CGW NA 60
R 236	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW NA 60
R 237	12123880A	RFF 8.25K 5CC MW F+-1%	16299	CGW NA 60
R 238	12125560A	RFF 383.0 K 500.0MW F+-1%	16299	CGW NA 60
R 239*	09101200A	RVF 100.0K 250.0MWK CERMET	73138	HELIPOT 72XW VERT MT
R 240	12124480A	RFF 31.6 K 500.0MW F+-1%	16299	CGW NA 60
R 241*	09100930A	RVF 10.0K 500.0MWK VERT MT	73138	HELIPOT 72XW 10K
R 243*	09100930A	RVF 10.0K 500.0MWK VERT MT	73138	HELIPOT 72XW 10K
R 246	12122840A	RFF 75C.C 5CC MW F+-1%	16299	CGW NA 60
R 247*	09100940A	RVF 500.0 500.0MWK VERT MT	73138	HELIPOT 72XW 500
R 248	12122840A	RFF 75C.C 5CC MW F+-1%	16299	CGW NA 60
R 249	12125680A	RFF 511.C K 500 MW F+-1%	16299	CGW NA 60
R 250	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW NA 60
R 251	12123480A	RFF 3.16K 5CC MW F+-1%	16299	CGW NA 60
R 252	12C10020A	RFC 6.8 M 500 MW K+-10%	C1121	A-B TYP EB
R 253	12C10020A	RFC 6.8 M 500 MW K+-10%	01121	A-B TYP EB
R 254	12125480A	RFF 316.0 K 5CC MW F+-1%	16299	CGW NA 60
R 255	12123680A	RFF 5.11K 500 MW F+-1%	16299	CGW NA 60
R 256	12124240A	RFF 17.8 K 5CC MW F+-1%	16299	CGW NA 60
R 257*	08100930A	RVF 10.0 K 500.0MWK VERT MT	73138	HELIPOT 72XW 10K
R 301	12123080A	RFF 1.21K 500 MW F+-1%	16299	CGW NA 60
R 302	12121680A	RFF 51.1 500 MW F+-1%	16299	CGW NA 60
R 303	12122720A	RFF 562.C 5CC MW F+-1%	16299	CGW NA 60
R 304	12122160A	RFF 147.0 500 MW F+-1%	16299	CGW NA 60
R 305	12122520A	RFF 348.C 5C0 MW F+-1%	16299	CGW NA 60
R 306	12122600A	RFF 422.C 5CC MW F+-1%	16299	CGW NA 60
R 307	12122760A	RFF 619.0 500 MW F+-1%	16299	CGW NA 60
R 309	12121560A	RFF 38.3 5C0 MW F+-1%	16299	CGW NA 60
R 310	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 311	12124280A	RFF 19.6 K 500 MW F+-1%	16299	CGW NA 60
R 312	12123000A	RFF 1.C K 5CC MW F+-1%	16299	CGW NA 60
R 313	12122160A	RFF 147.0 500 MW F+-1%	16299	CGW NA 60
R 314	12121560A	RFF 38.3 5CC MW F+-1%	16299	CGW NA 60
R 315	12122680A	RFF 511.C 5CC MW F+-1%	16299	CGW NA 60
R 320	12123940A	RFF 9.53K 500 MW F+-1%	16299	CGW NA 60
R 401	12121210A	RFF 16.5 5CC MW F+-1%	16299	CGW NA 60

Optionally available as internal adjustments. Ballatine part numbers are: R239, P/N09101160A; R241 and R243, P/N09101240A; R247 and R257, P/N09101250A.

Main P.C. Board (3045A and 3046A, Serial No. Prefix 020- thru 023-) - Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 402	12122680A	RFF 511.0 500 MW F+-1%	16299	CGW NA 60
R 403	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW NA 60
R 801	12123720A	RFF 5.62K 500 MW F+-1%	16299	CGW NA 60
R 802*	12123180A	RFF 1.54K 500 MW F+-1%	16299	CGW NA 60
R 802**	12123200A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 803**	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW NA 60
R 804	12123760A	RFF 6.19K 500 MW F+-1%	16299	CGW NA 60
S 2	2510C901A	SWC TOGGLE 3PDT PC MTG	09353	C+K 73C1SYAV2 NON THD
S 4	25100760A	SWC TOG SPDT PC VERT NON THD	09353	C+K 71C1 SY AV2 NON THD
S 5	2510C750A	SWC TOG DPDT PC VERT NON THD	09353	C+K 7201 SY AV2 NON THD
S 6	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040
S 1A	25100781A	SWC PART OF 25100771A	50423	
S 1B	2510C531C	SWC SECT 1&2 OF 25-10C55-1C	11236	CTS SER 212 12 P05
S 1C	25100791A	SWC PART OF 25100771A	50423	
S 1D	25100731A	SWC PART OF 25100551E	11236	CTS
S 1F	2510C541B	SWC SECT 3&4 OF 25100551C	50423	
S 1F	251005818	SWC SECT 5 OF 2510C55-1C	50423	
T 401	2C1CC210A	TRX POWER (3045A)	08779	SIGNAL TRANS CPC-56-180
Z 401	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A1C
F 2	19100060A	FUS 0.125A PICOFUSE PIGTAIL	75915	LITTELFUSE 275.125
		OPTION MOD-05 (RECHARGEABLE BATTERY) ALSO INCLUDES:		
CR 501	C5C752CCA	DGP 1N4148 GE CR	07263	FAIRCHILD,FCH 600
CR 502	05C79200A	DGP 1N4148 GE CR	07263	FAIRCHILD,FCH 600
CR 503	C5C752CCA	DGP 1N4148 GE CR	07263	FAIRCHILD,FCH 600
CR 504	C5C8C580A	DGP 1N4CC6	15238	ITT
Q 501	10100040A	TRQ NPN 30V 25W SI MJE520	04713	MOTOROLA
R 403	12125000A	RFF 100.0 K 5CC MW F+-1%	16299	CGW NA 60
R 501	12124440A	RFF 28.7 K 500 MW F+-1%	16299	CGW NA 60
R 502	C91CC55CA	RVF 5C.C 5C0.CMWM	73138	HELIPOT 72PM 5C
R 503	12122240A	RFF 178.C 5CC MW.F+-1%	16299	CGW NA 60
S 501	2510C620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-5C-5PN785C4C

Front Panel (3045A, Serial No. Prefix 020- thru 023-)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	1610CC00A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5C82-444C
J 1	31C33790A	CON UG-1C94/U BNC,DAGE	29587	STATE ELECT.PARTS
M 201	18100261F	MTR 3045A 1MA	50423	
S 1	2510C771A	SWC 3C45A RANGE	11236	CTS REPLACES 25100551E
S 10	25C77860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #46256LF

Front Panel (3046A, Serial No. Prefix 020- thru 023-)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
DS 1	16100000A	LMP PAN GALLIUM ARSENIDE	28480	(H-P)-5082-4440
J 1	31033790A	CON UG-1094/U BNC, DAGE	29587	STATE ELECT. PARTS
M 201	1810C1C1H	MTR 3C3EA 1MA FS	50423	
R 601	09101041A	RVC 1C.CK 25C.OMWM TAPER A	11263	CTS RS200 1/4EL .5PL SHFT
R 602	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
S 601	C91C1C41A	RVC 1C.CK 250.CMWM TAPER A	11263	CTS RS200 1/4EU .5PL SHFT
S 1	25100771A	SWC 3045A RANGE	11236	CTS REPLACES 25100551E
S 10	25077860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #462561F

Used on 3045A ** Used on 3046A

Rear Panel (3045A and 3046A, Serial No. Prefix 020- thru 023-)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 1A	17100000A	FLE POWERLINE FILTER 25CV	50423	
C 1B	17100000A	FLE POWERLINE FILTER 250V	50423	
F 1	1SC3410CA	FUS C.4 AMP. TYPE MDL	71400	BUSSMANN SLC-BLOW
J 2	31033790A	CON UG-1094/U BNC.DAGE	29587	STATE ELECT.PARTS
J 3	31033790A	CON UG-1094/U BNC.DAGE	29587	STATE ELECT.PARTS
J 5	311C0000A	REC AC POWER	82389	SWITCHCRAFT
J 6	31073290A	BPS BINDING. NYLON. BLK.	83330	H.H.SMITH #1517
J 7	31C82120A	BPS #1517. NYLON.WHITE	83330	H.H.SMITH
J 8	31100770A	BPS CNC	83330	HH.SMITH 1518
J 9	31073290A	BPS BINDING. NYLON. BLK.	83330	H.H.SMITH #1517
J 10	31C82C20A	BPS #1517 RED	83330	H.H.SMITH
R 1	12127330A	RFC 22.0 2.0 WK	C1121	A-B TYP HB OR EQUIV

OPTION MOD-04 (REAR INPUT) ALSO INCLUDES:

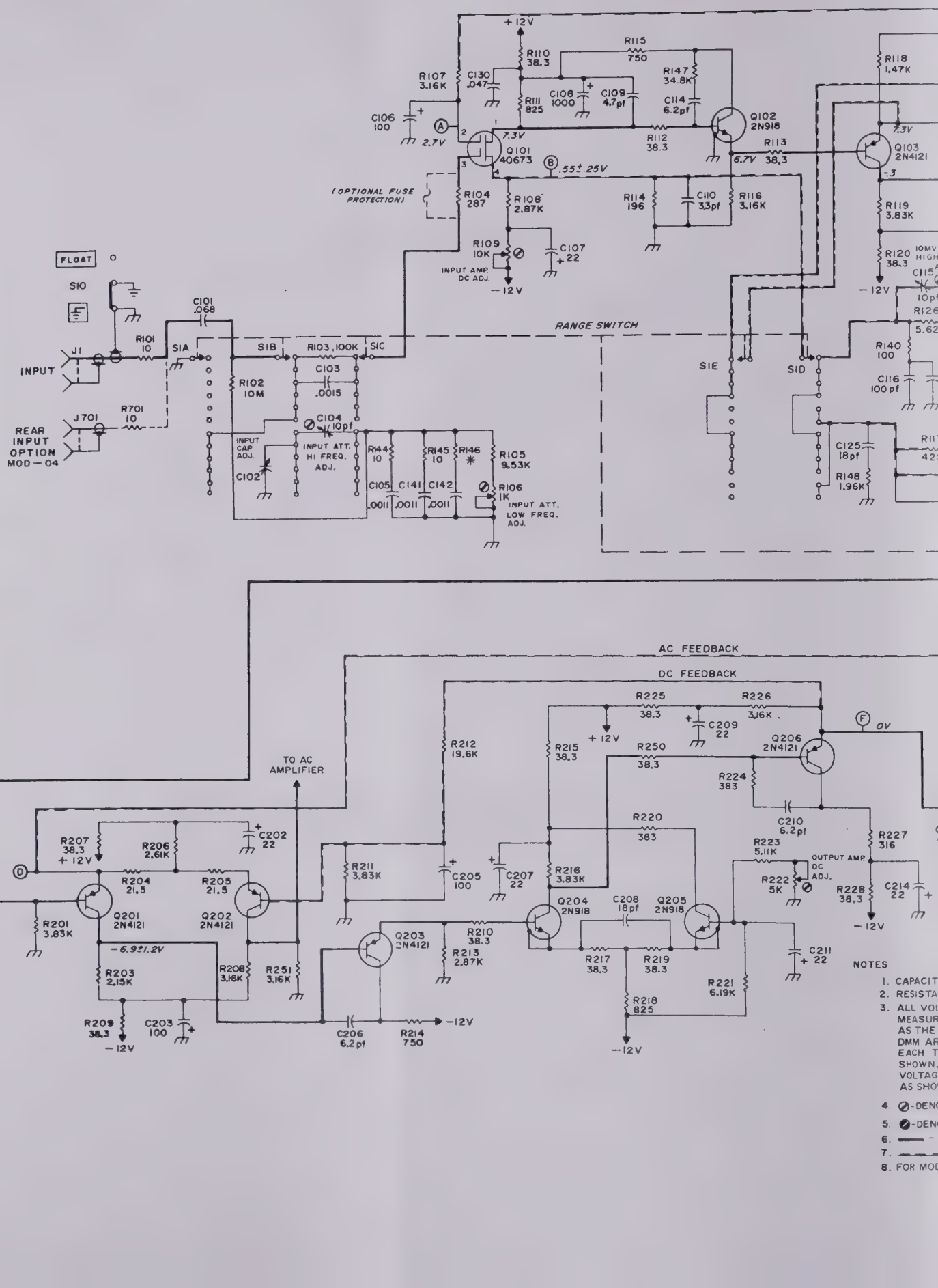
J 701	31033790A	CON UG-1094/U BNC.DAGE	29587	STATE ELECT.PARTS
R 701	12121000A	RFC 10.0 500 MW F+-1%	16299	CCW NA EC

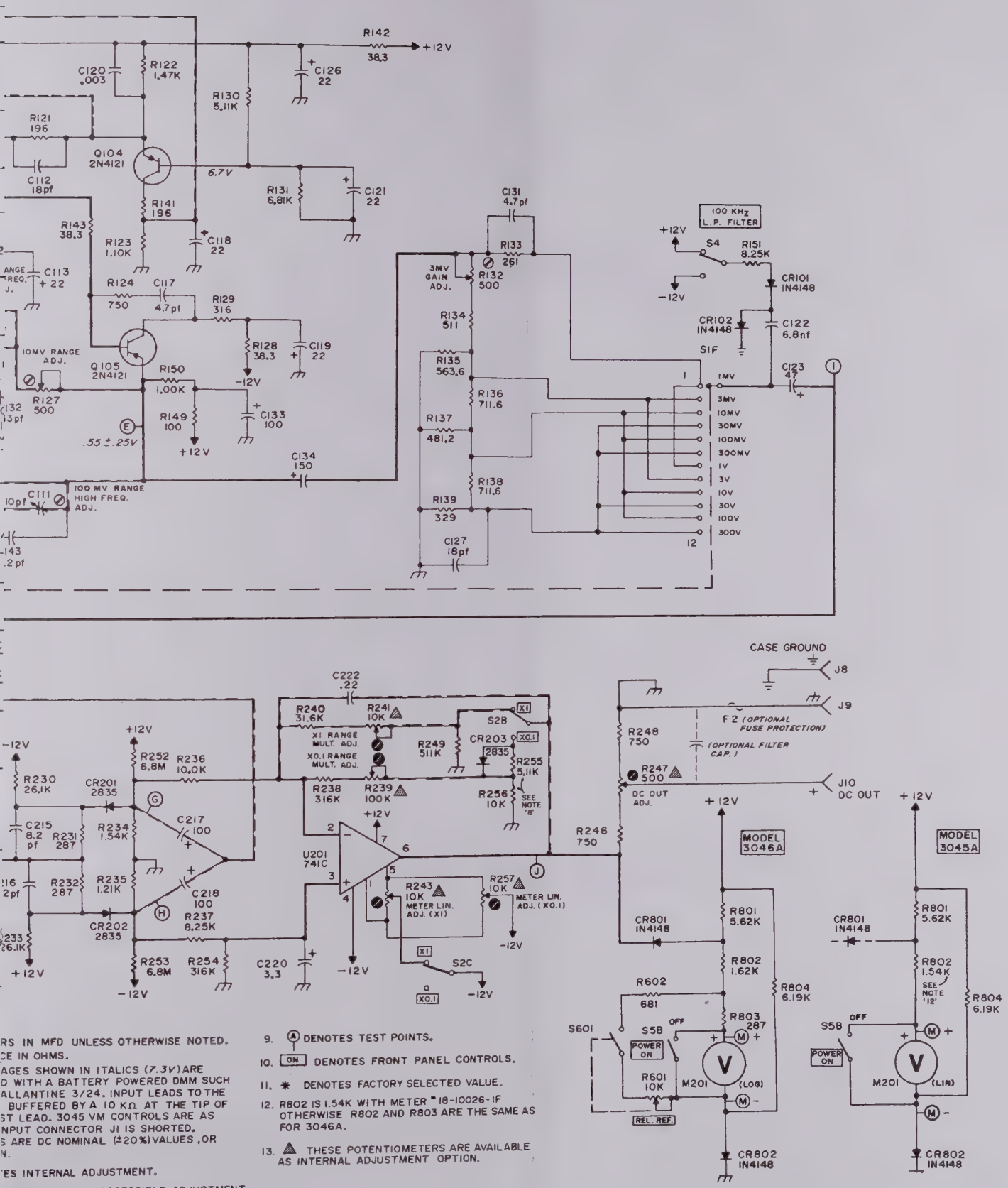
OPTION MOD-05 (RECHARGEABLE BATTERY) ALSO INCLUDES:

—	35100381F	BKT 3045A BAT SUP	50423	BLI
—	851CC39CA	BAT 28.8 V .6AMP-HRS	24446	GE PPS 2178 7325

Miscellaneous (3045A and 3046A, Serial No. Prefix 020- thru 023-)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
—	1S1CC14CA	FSH SQUARE MOLDED GRAY	75915	LITTLEFUSE 348-8-9-9
—	33100000A	LNC LINE CORD SET 7FT.MLD	70903	BELDEN CORD SET BN772
—	371CC121L	PLT DECORATIVE SIDE STRIP	50423	
—	40100040A	CAK 10MM BLACK	50423	
—	4C1CC290A	KNB 10MM BLK 4MM SHAFT W/LIN	50423	
—	4C1CC340A	COV 10MM BLK WITH LINE	50423	
—	44C87880A	ASY BALL & FOOT ASY. 6.6 IN	21604	BLCKEYE
—	511003111L	COV 3045 SER TOP	50423	BLI
—	511CC3210	COV 3045 SER BOTTOM	50423	BLI

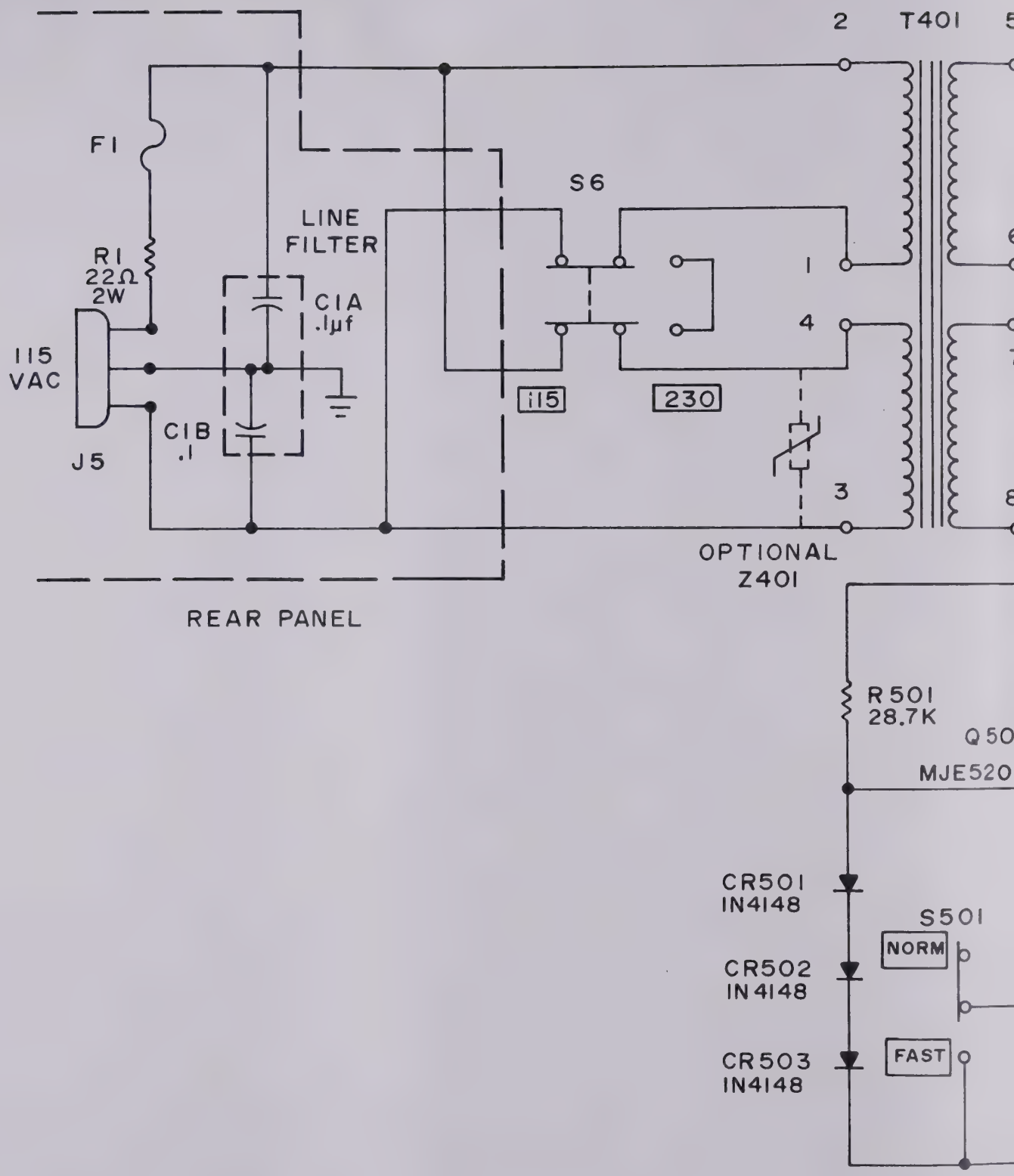

+12V
R110 38.3
R115 750
R107 3.16K
C130 .047
C108 1000
C109 4.7pf
R147 34.8K
C114 6.2pf
R118 1.47K
C106 100
2.7V
Q101 40673
7.3V
R112 38.3
Q102 2N918
R113 38.3
6.7V
Q103 2N4121
.55±.25V
(OPTIONAL FUSE PROTECTION)
R104 287
R108 2.87K
R114 196
C110 33pf
R116 3.16K
R119 3.83K
R109 10K
INPUT AMP. DC ADJ.
C107 22
-12V
R120 38.3
FLOAT
S10
C101 .068
RANGE SWITCH
J1
INPUT
R101 10
S1A
S1B
R103, 100K
S1C
S1E
S1D
R102 10M
C103 .0015
J701
R701 10
REAR INPUT OPTION MOD-04
C104 10pf
INPUT CAP ADJ.
C102
INPUT ATT. HI FREQ. ADJ.
R144 10
R145 10
R146 *
R105 9.53K
C105 .0011
C141 .0011
C142 .0011
R106 1K
INPUT ATT. LOW FREQ. ADJ.
R140 100
C116 100 pf
C125 18pf
R148 1.96K
AC FEEDBACK
DC FEEDBACK
TO AC AMPLIFIER
R225 38.3
R226 3.16K
C209 22
+12V
R212 19.6K
R215 38.3
R250 38.3
Q206 2N4121
0V
R224 383
C210 6.2pf
R220 383
R227 316
R223 5.11K
OUTPUT AMP DC ADJ.
R222 5K
R228 38.3
C214 22
R207 38.3 +12V
R206 2.61K
C202 22
R204 21.5
R205 21.5
R211 3.83K
C205 100
C207 22
R216 3.83K
Q201 2N4121
Q202 2N4121
Q204 2N918
C208 18pf
Q205 2N918
R201 3.83K
-6.9±1.2V
R210 38.3
C211 22
Q203 2N4121
R213 2.87K
R217 38.3
R219 38.3
R221 6.19K
R203 2.15K
R208 3.16K
R251 3.16K
R218 825
R209 38.3
C203 100
C206 6.2pf
R214 750
-12V
NOTES
1. CAPACIT
2. RESISTA
3. ALL VO
MEASUR
AS THE
DMM AR
EACH T
SHOWN.
VOLTAG
AS SHO
4. -DEN
5. -DEN
6. —
7. —
8. FOR MOD



RS IN MFD UNLESS OTHERWISE NOTED.
CE IN OHMS.
AGES SHOWN IN ITALICS (7.3V) ARE
D WITH A BATTERY POWERED DMM SUCH
ALLANTINE 3/24. INPUT LEADS TO THE
BUFFERED BY A 10 KΩ AT THE TIP OF
ST LEAD. 3045 VM CONTROLS ARE AS
NPUT CONNECTOR J1 IS SHORTED.
S ARE DC NOMINAL (±20%) VALUES, OR
N.
ES INTERNAL ADJUSTMENT.
ES EXTERNALLY ACCESSIBLE ADJUSTMENT.
NOTES MAIN SIGNAL PATH.
DENOTES FEED-BACK PATH.
L 3046A-R255 IS 10.0K AND R256 IS 5.11K.

9. Ⓐ DENOTES TEST POINTS.
10. ON DENOTES FRONT PANEL CONTROLS.
11. ✱ DENOTES FACTORY SELECTED VALUE.
12. R802 IS 1.54K WITH METER ≠ 18-10026-1F OTHERWISE R802 AND R803 ARE THE SAME AS FOR 3046A.
13. ⚠ THESE POTENTIOMETERS ARE AVAILABLE AS INTERNAL ADJUSTMENT OPTION.

Figure 7-1. 3045A and 3046A, Schematic Diagram (Serial No. Prefix 020- thru 023-)


2
T401
F1
S6
LINE
FILTER
R1
22Ω
2W
C1A
.1μf
115
VAC
C1B
.1
J5
115
230
1
4
3
OPTIONAL
Z401
REAR PANEL
R501
28.7K
Q50
MJE520
CR501
IN4148
S501
NORM
CR502
IN4148
CR503
IN4148
FAST

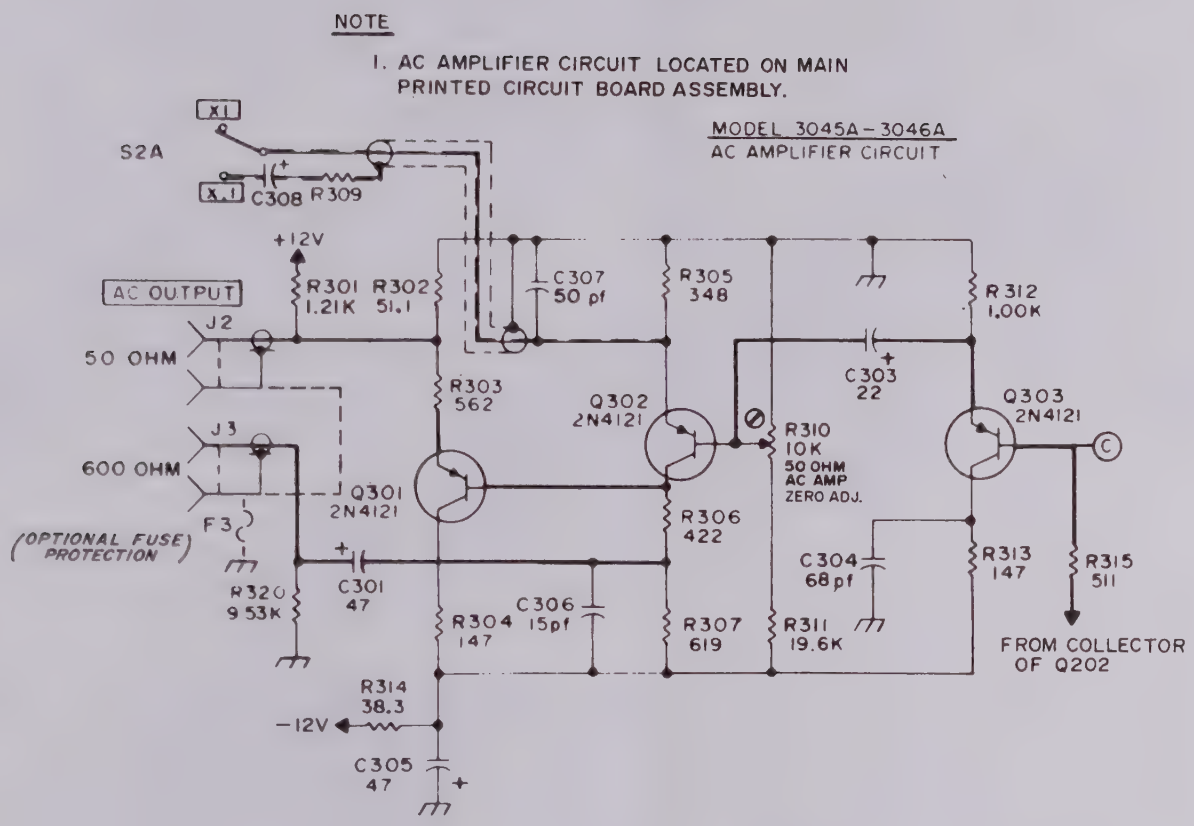
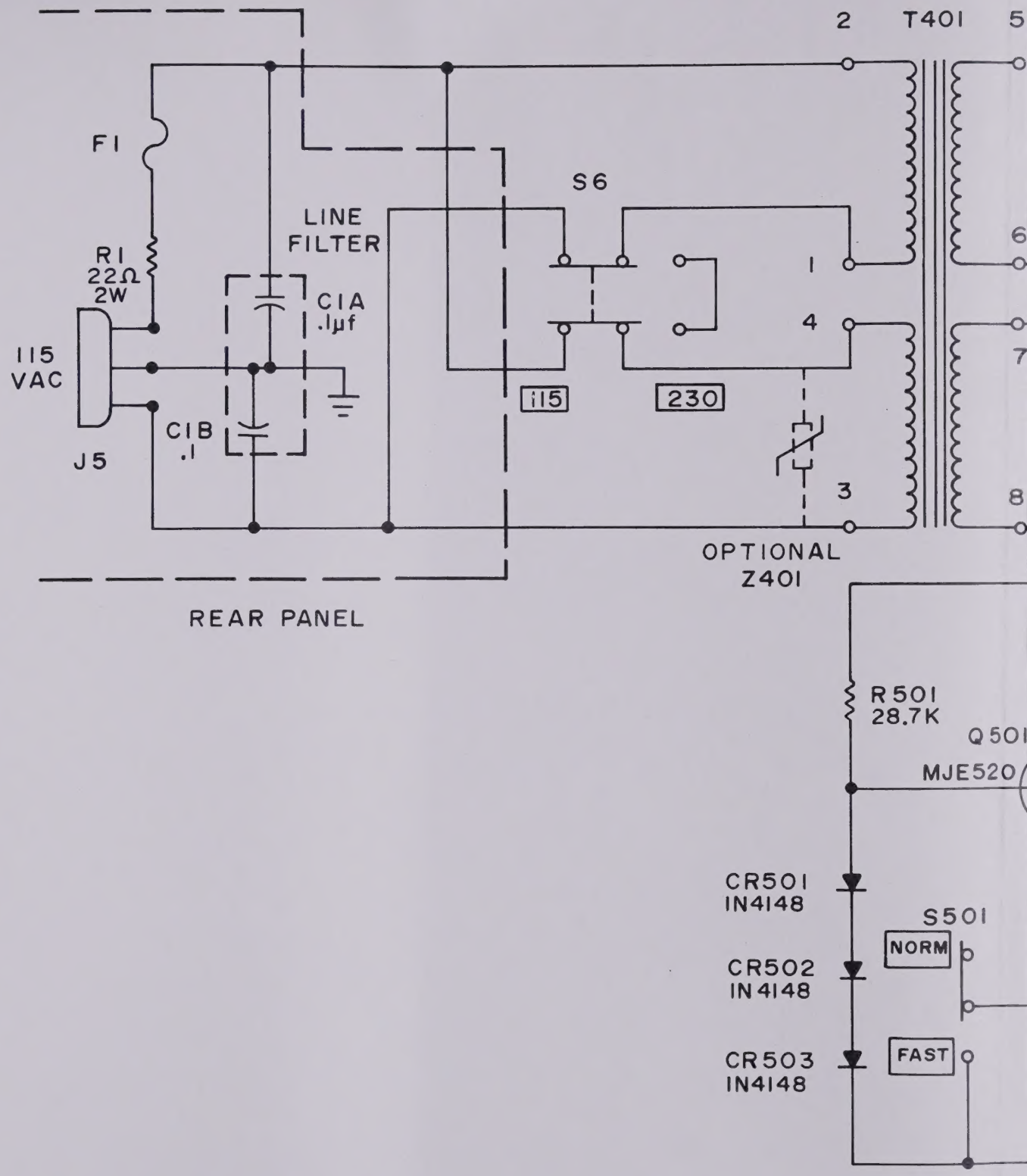


Figure 7-2. 3045A and 3046A, AC Amplifier, Schematic Diagram (Serial No. Prefix 020- thru 023-)


2
T401
5
F1
S6
LINE
FILTER
6
R1
22Ω
2W
C1A
.1μf
1
4
7
115
VAC
115
230
C1B
.1
J5
3
8
OPTIONAL
Z401
REAR PANEL
R501
28.7K
Q501
MJE520
CR501
IN4148
S501
NORM
CR502
IN4148
CR503
IN4148
FAST

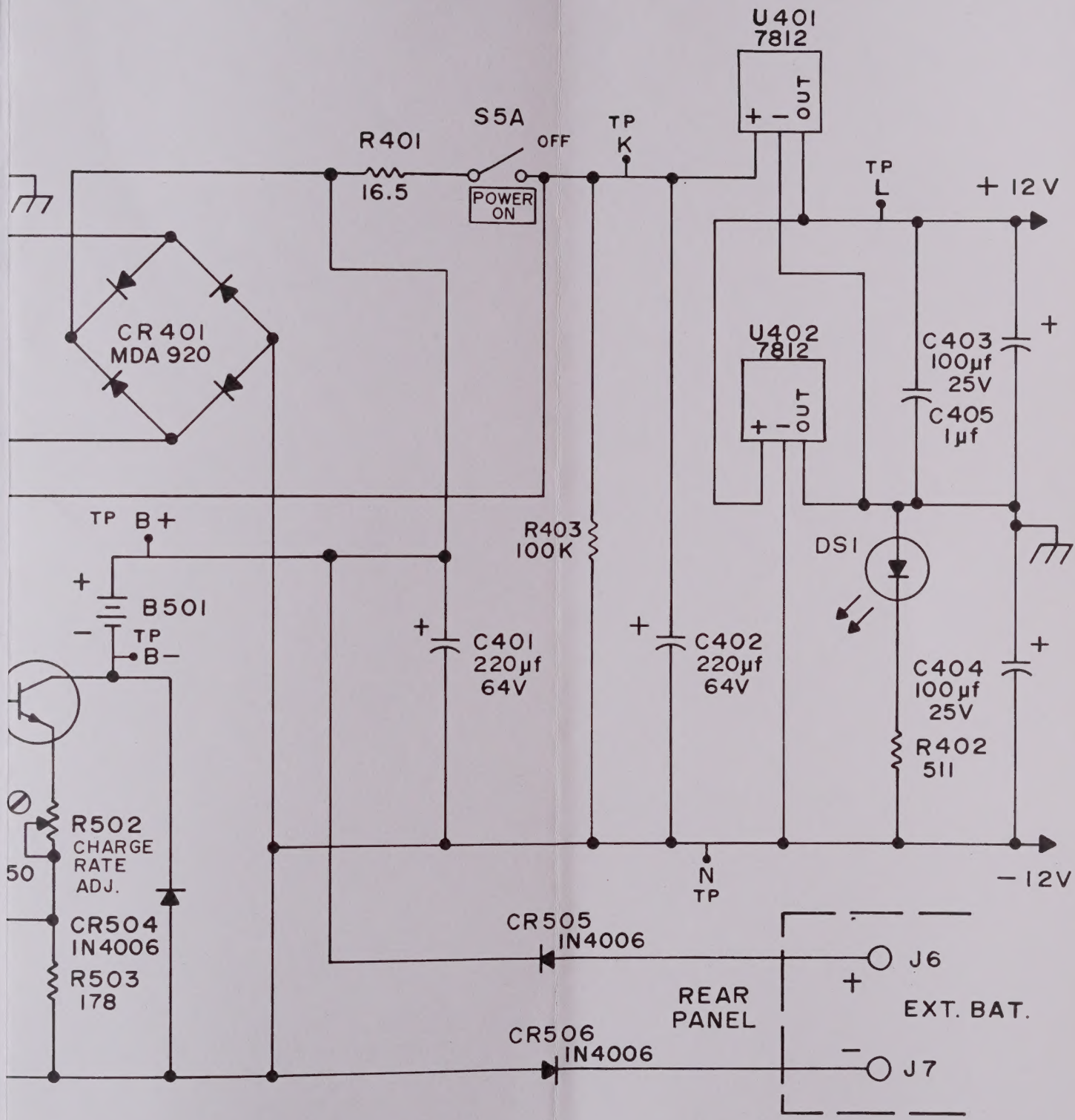


Figure 7-3. 3045A and 3046A, Power Supply, Schematic Diagram (Serial No. Prefix 020- thru 023-)

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